THE JOURNAL OF
Engineering Education

December, 1954 Vol. 45, No. 4

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Published monthly (except during July and August) at Prince and Lemon Sts., Lancaster, Pa., by the American Society for Engineering Education under the Supervision of the Publication Committee: A. B. Bronwell, Chairman, Northwestern University, L. E. Grinter, N. W. Dougherty, F. M. Dawson, G. W. Farnham, E. A. Walker, C. E. Watson, Editor. Entered as second class matter, October 17, 1912, at the Post Office at Lancaster, Pa., under the act of August 12, 1912. Subscription Price, $6.00 per year; Yearbook Issue, $6.00; Single Copies, $1.25.

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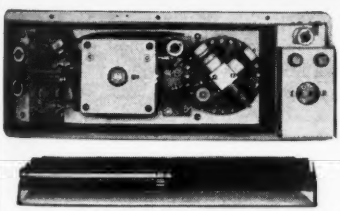

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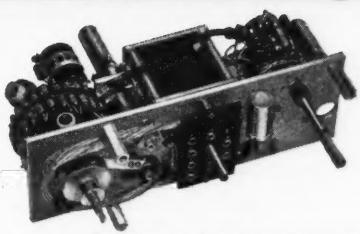

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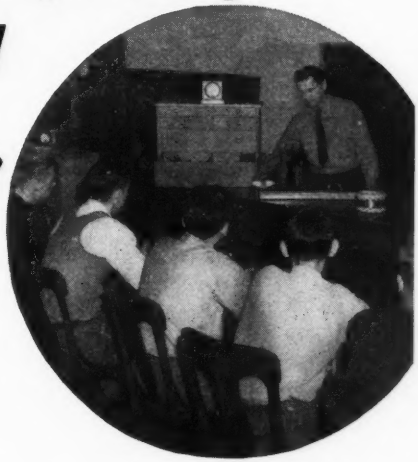

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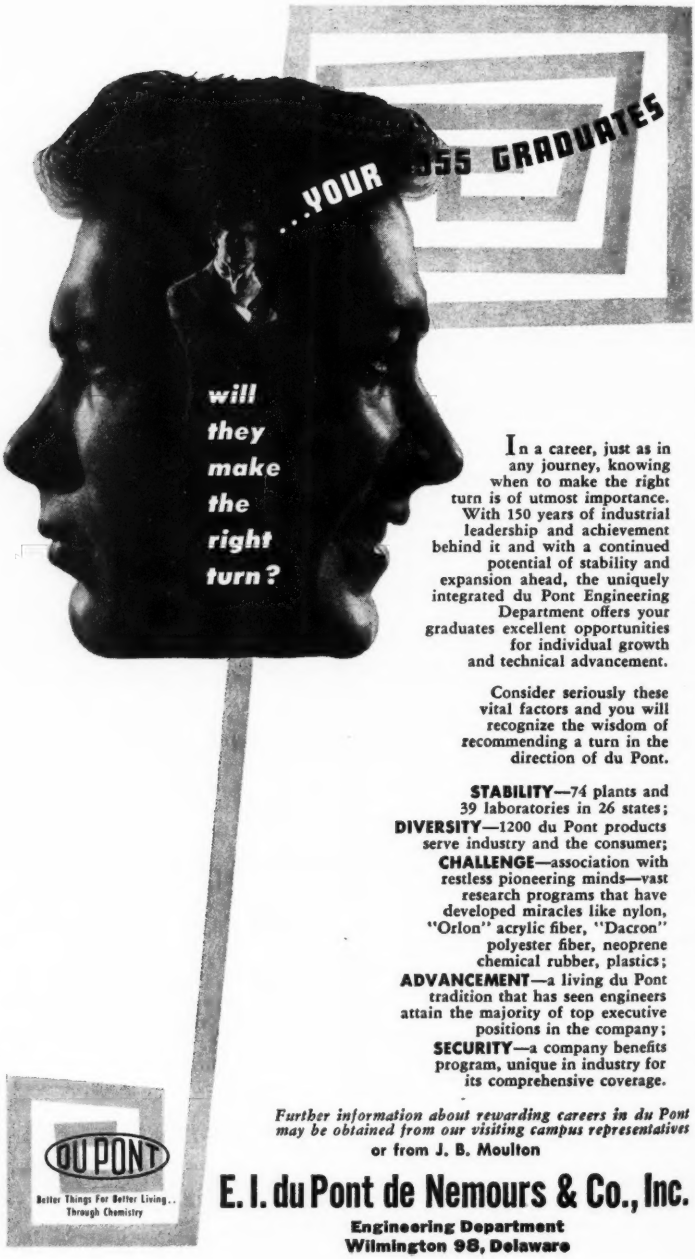

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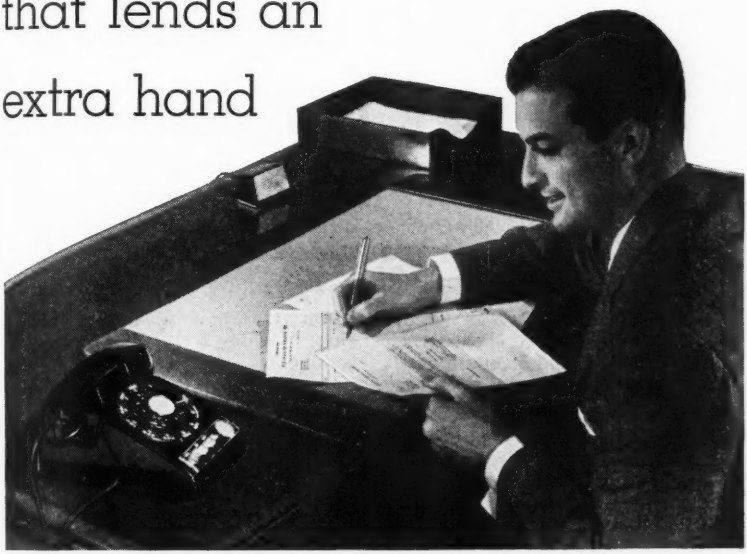

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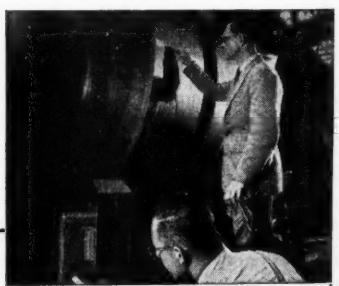

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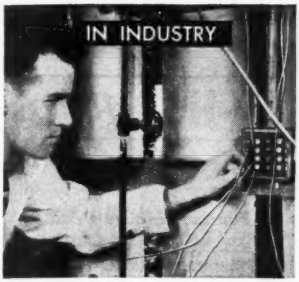

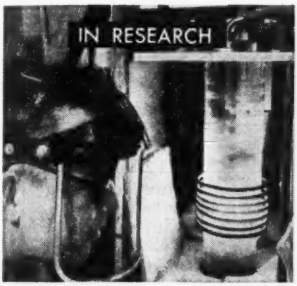

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▶ We have just received word from Vice President Web. Jones at Carnegie Institute that the Secretary of Defense, Charles Wilson, who is an alumnus of Carnegie Institute, has accepted an invitation to be our banquet speaker at the Annual Meeting at Pennsylvania State University. An excellent program is shaping up for the Annual Meeting this June. The ECAC–ECRC will again hold their Joint Dinner, an event which proved to be one of the highlights of the Annual Meeting last year.

▶ One of the General Sessions at the Annual Meeting will include a resume of results of the Humanistic-Social Research Project, which is now making very substantial gains under the able direction of Dr. George Gullette. This General Session will also present the wind-up report of the ASEE Committee on Evaluation of Engineering Education, with particular emphasis on looking ahead in experimentation and trends in engineering education. President Dougherty will also give his presidential address at this General Session.

▶ Another General Session will deal with the subject of Education for Research, considering the dual subject of how to educate for research and also the educational values which accrue from research. The Administrative Council is considering a General Session dealing with various successful methods which are being employed to attract and sustain interest of high school students in science and engineering.

▶ The local committee at Pennsylvania State University is fully organized now and is doing a grand job in planning the facilities, recreation, and entertainment for the Annual Meeting so as to make this a memorable event in ASEE activities.

▶ Two Summer Institutes and two Summer Conferences were approved by the Executive Board and the General Council at their last meeting. One of these Summer Institutes will deal with the subject of Thermodynamics as seen by the physicist, the chemical engineer, the chemist, and the mechanical engineer. So far, their diverse viewpoints are quite irreconciliable in both subject matter and methods of approach to the subject. It would be helpful if each understood the other's viewpoint. A cross-fertilization of ideas might yield very substantial benefits to all. The proposal is to hold a closed conference of leading authorities on this subject at Purdue University and an open conference at Pennsylvania State University at about the time of the Annual Meeting.

▶ A second Summer Institute, which is shaping up now, will deal with advanced mathematical methods as applied to engineering problems. It is hoped that this Summer Institute might emphasize the similarities in methods of approach in many different fields of engineering and physics. It would seek out ways of achieving greater unity in methods of presentation. The specific plans for this Summer Institute have not been formulated as yet, but we will keep you posted.

▶ Two additional conferences are contemplated, one dealing with the subject of engineering mechanics and the other with electricity and magnetism. These conferences will bring together leading educational authorities in these fields to

discuss the correlation of subject matter with a view toward getting a better organization of material and more efficient methods of handling these courses. These conferences will then be the basis of papers and discussions at the Annual Meeting at Pennsylvania State University.

► The Catalogue of Learing Aids will soon be available—the price $1.00 each. It lists almost 300 teaching aids which are regarded as the best available for teaching purposes. Over 5,000 aids were reviewed. Send remittance for your copy now—ASEE, Northwestern University, Evanston, Illinois.

► You can still get copies of the Interim Report of the ASEE Committee on Evaluation of Engineering Education from ASEE headquarters—price 20¢ each, or 12¢ in lots of 100 or more. Over 8,000 copies have been sold—this report has vaulted into the "best-seller" category.

► Your Secretary has been invited to take the position of President of Worcester Polytechnic Institute and will be leaving this post on February 1. It has been a grand experience to serve as Secretary of the Society for the past seven years and to have had the privilege of working with leaders in engineering education throughout the country. Naturally, it is with a great deal of reluctance that I terminate this very pleasant association. I shall always be wholeheartedly interested in the welfare of ASEE and I hope to be able to continue to assist in some of the major projects of the Society. During the past seven years, the Society has made some very substantial gains and it has stimulated a liberal outlook toward engineering education which keeps it responsive to the challenges of the advancing times. This is a high tribute to the able and enthusiastic leadership of your officers and the very effective work of many members of the Society. They have been a grand group to work with and the Society owes them a deep debt of gratitude for their dedicated service.

► We will be seeing you at the Annual Meeting at Pennsylvania State University on June 20–24. Bring the family and plan a real vacation.

Sincerely yours,
ARTHUR BRONWELL, *Secretary*

Professional Development of Engineering Teachers*

By N. W. DOUGHERTY

President of ASEE, Dean of Engineering, The University of Tennessee

You are fortunate in living in a day which is fraught with change and a consciousness of change. Teachers do not expect to make an outline today which will last for several years; they expect to make improvements every time they give the course. Their time may be expended on their work in an atmosphere of research, writing and teaching without having to consider whether science and technology will be acceptable to those who administer the college or university.

The battle of science and utility has been won; our forebears have placed engineering teaching on a parity with any kind of education. We do not need to defend ourselves against educational critics, since our type of education has general acceptance. Herbert Spencer, and a long line of science and engineering writers, have placed utility education alongside any other type of teaching which has survived the changing times.

One hundred seventeen years ago Emerson,[1] made a prophesy which has come true:

> Our day of dependence, our long apprenticeship to the learning of other lands, draws to a close. The millions that are around us rushing into life cannot always be fed from the sere remains of foreign harvests.

Engineering teachers have not only won the battle of acceptance into the halls of the educated, but they have declared their independence of any other cultures. Delegations from other lands are coming to us to learn our methods of applying science to industry with such abundant harvests. We have developed our own method of education, we have produced our own literature of engineering, we have built our own kind of civilization. In our thoughtful moments we will find errors; we will make some real changes, but the kind of teacher you are destined to be is indigenous to our soil.

We must make college more than a place to gather information about earning a living. It must be a place where the torch of learning is lighted and will continue to flame through a whole professional career. It is more important to get the spirit of the scholar than to learn the multiplication tables or Newton's laws, though these too are essential.

Our education is slowly evolving from the study of an art and method to a study of basic laws and reasons why. Engineering and agriculture were the first major disciplines to come out boldly for utility, and the application of science to foods and production; we learn mathematics and science because they are useful in making a living.

The educators of the last century looked at our predecessors as if they were committing sacrilege when they elevated technology to a college curriculum. Hear this from the beginning of the last century: [2]

*Presented at the Young Engineering Teachers Banquet, Annual Meeting of ASEE, University of Illinois, June 14, 1954.

[1] "The American Scholar," Ralph W. Emerson.

[2] "Democratic Education," Benjamin Fine.

With the study of the Greek and Latin languages, sound learning flourishes or declines. It is now too late for ignorance, indolence, eccentricity, or infidelity to dispute what has been ratified by the seal of the ages.

Now the seal of the ages has been attached to the kind of education which we foster, though we still have a few small voices who would turn us away from the task of teaching the things which the students need to know.

When I first prepared this outline I was tempted to dwell upon your first five years of teaching. I outlined many of the problems such as routines and elementary work, small compensation and the balancing of budgets, the beginnings of a family, supplementary income, the virtues of extra work and summer employment, apparent neglect by superiors, hack-work, delay in promotions and that *advanced degree*. I did not have a ready solution, except persistence and hard work. Then I realized that you knew the problems as well as I did, and that no useful purpose would be served in dwelling upon palliatives.

For those who can take an advanced degree in their stride, it is a worth while achievement; for those who have had to extend themselves, it is the top rung of their educational careers. They go from there as wells which have been pumped dry, as springs which have had the pall of drought placed upon them. Their energy is spent, their ambition is gone, henceforth, they must assume the role of critic and pedant.

Those who take the doctorate in their stride think of it as an incident rather than a goal. They go on to new problems and new methods, always seeming fresh and ready for new developments.

Love for Teaching Essential

Dean Hazen in his "Letter [3] to a College President" has placed the following valuation on advanced study: "In a case of a man in his 30's, or even 40's, we are interested to see if he has a doctorate, since if he has, it is evidence that he has had sufficient scholarly interest to go on for graduate work and research. But the doctorate of itself is neither necessary nor sufficient evidence of the quality for which we are looking."

Of greater importance than advanced degrees is interest in and love for teaching. It is more than just a way of making a living, or even a desirable occupation; it is a dynamic way of engaging a life work. One of the keys to good teaching is expressed by William L. Phelps: [4]

> I do not know that I could make entirely clear to an outsider the pleasure I have in teaching. . . . In my mind, teaching is not merely a life-work, a profession, an occupation, a struggle: it is a passion. I love to teach. I love to teach as a painter loves to paint, as a musician loves to play, as a singer loves to sing, as a strong man rejoices to run a race.

If I can help you get enthusiastic about teaching, I will do you a greater service than to tell of the rough places and suggest ways of getting over them.

In teaching there is no substitute for knowledge of the subject, but that is not enough. The good teacher has love for his work; he has a sense of humor, is energetic, has personal charm; he is a director of discussion and not a tyrant; he is a teacher of students rather than of subject matter.

There are available many books and magazine articles on the art and science of teaching. It will be worth our while to mention a few and suggest that you enlarge the list by constant study in the field. A number of year ago I acquired a copy of "An Open Letter to College Teachers," by Payne and Spieth, which was very helpful. If you have read it you will find that many of the ideas I

[3] April and May 1954 issues of *Electrical Engineering*.

[4] "Teaching in Schools and Colleges," Phelps.

have expressed as my own have parallel expression in the book. It is a down-to-earth analysis of teaching which notes the virtues of good teaching and recognizes the faults of the poor teacher. Chapter VI suggests a study of the methods of great teachers and gives some brief notes on a few who have been nationally recognized as being very good. This chapter has a special appeal to me because I think biographical studies are good in science, in engineering and in teaching. I suggest a reading of Conant's little book "On Understanding Science," an historical approach, as a sample of the method and approach.

"Teacher in America," by Jacques Barzun, is very readable and it gives a rather unique approach to the subject of teaching. A sample paragraph will give a taste of his method:

> It takes the stubborness of a saint coupled with the imagination of a demon for a teacher to pursue his art of improvisation gracefully, unwearyingly, endlessly.
> Hence young teachers are the best; they are the most energetic, most intuitive, and least resented.
> Consequently, the whole aim of good teaching is to turn the young learner, by nature a copycat, into an independent, self-propelling creature, who cannot merely learn but study—that is, work as his own boss to the limit of his powers.

Engineering teachers have been prone to look down their noses at the works from the college of education, and I must admit that many of their books are not very impressive, yet they are specialists in their fields.

William James was a prophet and priest of educational psychology toward the end of the last century. His talks to teachers are still readable today:

> The genius of the interesting teacher consists in sympathetic divination of the sort of material with which the pupil's mind is likely to be already spontaneously engaged, and in the ingenuity which discovers paths of connection from that material to the matters to be newly learned.

Tie the new idea to the old or one which has interest to the student, and he will grasp the new idea without initial resistance. You will note that the quotation from Barzun suggests that the young teacher is the best. There is much good evidence to support this view.

Biographical Approach

A sample of the biographical approach to teaching is given in the sketch of Bliss Perry, by Rollo Walter Brown, in *The Atlantic,* June, 1954. In describing his work, Mr. Brown says:

> They listened. They passed the word along that here was a man with something important to say. . . . He experienced a vast and honorable repute, and like any other sensitive, intellectually honest human being —like William James, for instance—he was deeply concerned that the repute be deserved.
> They knew that Bliss Perry was a great teacher. But as in the case of any other great teacher, they found it next to impossible to agree on what made him so. . . . The revelation comes—as far as it ever comes—through unanticipated overtones that later seem only evidences of the teacher's good sense; through the attitude always maintained by a teacher toward the taught; through what he does supplementary to his teaching; through the restorative concerns when he is entirely away from the world of the classroom.
> The overtones made it easy enough to feel the first purpose of Bliss Perry's teaching: he was an awakener.

We have all heard a college likened to a log, with a student on one end and Mark Hopkins on the other. This is a remark attributed to President Garfield, who was a graduate of Williams College when Hopkins was there as president and teacher.

> The man Mark Hopkins as he moved slowly forward through the elm-shaded street seemed to incarnate in his stately massive form and wide domed brow all the traditions of the old school, preserving its reverence for God and man, its high sense of

duty and justice, while he cast out all that was narrow and petty and looked out to the new vistas of knowledge opening before him with wide vision and deep understanding; holding fast to all that was best in the old and opening the way to that vast conception of the universe that was just beginning to dawn upon the mind of man.

"Biography of Mark Hopkins,"
J. H. Denison.

While the appearance of the teacher is not all important, it helps if the teacher looks his role. Professor Church was a little man, yet he was looked upon as a great man; Mark Hopkins was a big man, and his size helped to set him alongside the great.

We have given brief sketches of a few great teachers, let us close this part of the discussion by mentioning a few things which we all know. "All wish to be learned, but no one is willing to pay the price" was said by Juvenal at the beginning of the Christian era. It is as true today as it was centuries ago. Few students have the will and the compelling desire to get a real education. Much of our time must be spent, as was that of Ichabod Crane as "with the appalling sound of the birch, he urged some tardy loiterer along the flowery path of knowledge." We do not use the birch, but we are familiar with its equivalent in low marks and administrative discipline.

Much excellent material has been developed outside of the college of education. The JOURNAL OF ENGINEERING EDUCATION is filled with papers describing methods of teaching, methods of conducting laboratories, the objectives of certain courses, the place of subject matter, and the necessity for enthusiasm.

Homo sapiens learns in a certain way, and there is little profit in trying to teach him by other methods. He forgets at a certain rate and the teacher is barking up a tree when he insists that something was learned last year and he cannot take time for it today. Many things learned last year are forgotten, other things learned this year will also be forgotten; the teacher should recognize these facts and teach accordingly.

Good Teachers Rare

Good teachers are so rare that the rumor of one on the campus spreads with the speed of gossip.

There can be no doubt about the fact that the key to any program of effective instruction is dependent upon the instructor and not on the organization of the material, or the sympathy of the administrator, or even the instruction materials. Above all the helps, the devices and the equipment is the work of the teacher himself.

Personal interest and deep concern about the student vastly enlarge the horizon and greatly stimulate the effort.

It is good to mix theory with practical experience, by such a mixture both experience and theory are motivated. Long ago Vitruvius gave this advice:

> Architects who have aimed at acquiring manual skill without scholarship have never been able to reach a position of authority to correspond to their pains, while those who relied only upon theories and scholarship were obviously hunting the shadows, not the substance. But those who have a thorough knowledge of both, like men armed at all points, have the sooner attained their object and carried authority with them.

I cannot emphasize too much the desirability of acquiring some engineering experience along with the teaching. My best advice is to get such experience during the summer months, rather than to take off several years and enter industry. My experience in employing industrial workers as teachers has not been too promising. Leaven the teaching with engineering experience rather than leave teaching to spend long periods in industry.

To develop a spirit of unity in engineering and a professional attitude the teachers must become professional practitioners as well as educators. This does not mean that they must have intense

industrial experience, but rather that they take an active part in the movements designed to achieve professional recognition.

Professionalism has different meanings for different people, depending upon the context and their background. I wish to define the word for our purposes as meaning those attitudes and activities which distinguish a member of the "learned professions" from the skilled trades. Engineers' Council for Professional Development[5] has listed certain distinguishing characteristics of both a profession and a professional. Among those for a practitioner are ethical conduct, a service motive, a relation of confidence and membership in a group. A teacher must be thoroughly familiar with all the implications of professionalism, since most of the teaching in these areas is by contact, contagion, and example, rather than by class assignment and laboratory exercises.

Teachers must have enlightened ideas on such problems as fragmentation of the engineering profession. Year after year the number of new curricula and new options increase; nationally and locally the profession is organized into many separate groups. We talk about unity; we organize for unity, and yet each group goes its merry way breaking into smaller groups. Unity in the profession will probably come after a new generation of students has been conditioned for it. Should we emphasize the common elements in engineering education rather than the specialization we might take the first step. Teachers must become thoroughly familiar with the vested interests now causing slow progress toward unity, and then send out their students with a will to do something about getting it.

Recognition

For many years we have talked about recognition. Two wars have focused the light of publicity on the profession in such a way that all know engineers as the key to production and distribution. Further recognition is obtained by defining a professional and separating him from the interloper.

This is done by active participation in the technical societies, by support of the registration movement, and of course, by being an engineer worthy of the title. Much has been written about the effects of registration. Some of the claims have been very sanguine. and some of the criticism has been unfounded. We know that registration is here to stay; we know that thousands of engineers are registered in the several states, and we further know that to practice the profession an engineer must be legally registered by his state board. I do not go as far as the majority of the National Council about teachers, but I believe it is to the great advantage of the young teacher to get registered in his own state as soon as he is eligible. As court decisions accumulate, it becomes obvious that a registered professional is in a much different legal position from his colleague who is not registered.

I need not mention ethics, service and the relation of confidence except to say that students admire and imitate their teachers. They are very similar, except they are a little older, to the youngster who was following his dad to the garage. A little snow was on the ground, and the youngster called "Daddy, I'm coming." The father looked back and saw that the youngster was stepping in his tracks. He realized more than ever that, in fact, is what youngsters do.

Henry Van Dyke, in Little Rivers, makes the statement that the last touch of beauty is animation. I am convinced that the last touch of good teaching is enthusiasm and interest in those who are taught. Students cannot be treated as numbers; they must be treated is individuals. John Henry Newman in describing a university said: "An alma mater is a loving mother, knowing her children

[5] Report of Committee on Professional Recognition, ECPD, 1945.

one by one." The good teacher must know his students one by one, and his contact must take the nature of individual rather than group activity.

As I look at teaching for the next several years I am enthusiastic about the prospects. It is probable that the compensations will never be competitive with industry, but neither will industry be able to compete with the satisfactions which are available to the interested teacher. Engineering teaching will be doubly attractive, because of the possibility of industrial as well as educational interests.

A new age seems to be dawning. It is probably the logical development of the industrial revolution which has been on its way for nearly two centuries, and yet each generation during the revolution has had the feeling that it was at the cross-roads of progress. So is every generation; so are we; so will be our successors. In the great movements of civilization it may be that the individual cannot hinder, yet the record seems to show that individuals do add to its ebb and flow.

This quotation from the first paragraph of Harrison's "Atoms in Action," points to a new shore of Newtonian pebbles to be picked up by the next or the next generation:

> Whether yesterday was sunny or cloudy, a June day or a day in December, enough energy fell on the earth during that twenty-four hours to serve humanity for several centuries—enough to keep the world's furnaces roasting and its refrigerators icy, to spin its wheels and refine its ores, and to fill for several hundred years every other present need for power. The wheels of civilization are kept turning by energy; and all the energy, whether drawn from a gallon of gasoline, a ton of coal, or a pound of butter, has come from the sun.

This statement is obviously dated before 1945 and does not consider the energy of atomic fission. Yet the possibilities of capturing the energy of the sun poses a problem which some student will solve, and it may be that he will come from one of my classes or from one of yours. If we as teachers can stimulate students to search and to find we will multiply our efforts many times.

The Flight of Human Imagination

At each annual meeting of ASEE for the last several years we have had programs which undertook to look into the future of atomic fission. Each year new progress is reported; each year we realize the devastating effects of explosive use. We then look into a more distant future and see wheels turning, ships sailing, planes flying powered by this new energy. We dream of the new methods of constructing prime movers, we realize with Kettering that the only limit to new devices, new methods and new ideas is the flight of human imagination.

The young teacher of this generation will have to prepare engineers for next year and the next twenty-five years. He must grow with them, he must be able to inspire them to continue studying until the end of their careers.

If the teacher is enthusiastic about his work his students will respond; if he believes his work is drudgery his students will have the same attitude and no education will result. It is not telling them what they need to know; it is helping them find out for themselves what they need to know.

As one who has spent many years on the path I have traveled, you may wonder whether I would like to travel over the trail again. Had I to live it over, I would choose about the same life, with a little more study and a better husbanding of my financial resources, but with no major changes. It has been very pleasant indeed; the friends I have made; the books I have read; the classes I have taught, all are nostalgic to me.

You are at the beginning of the broad highway; the direction signs glare in neon lights, but some of us are like the old WPA worker who was also studying by class extension. He was poring over

his work when the teacher asked him how he was getting along: "On a road sign I have learned to tell how far, but I can't yet tell where to." This much we know: it will be a lifetime of activity, but we are not sure of the direction all the way.

Always there is expectation. The next fifty years will be more active than the last one hundred, yes maybe, than the last thousand. New knowledge may burst upon you like an atomic bomb, or it may come as it did to Elijah, in the still, small voice. Be awake and in tune in order that you may hear, whatever its tone and language. I can do no better than to close with the lines of Matthew Arnold:

Life consists not in getting and holding, but in being and becoming.

In the News

Architectural and engineering plans are nearing completion for the new headquarters building in Washington, D. C., of the **National Society of Professional Engineers.** Located in the Northwest section of the Capital, the approximately $300,000, four-story, granite frame building will house the executive and administrative offices of the 33,000 member Society. Financing of the new headquarters will be handled through the sale of building fund participation certificates to the membership.

ANNUAL MEETING

June 20-24, 1955

Pennsylvania State University
State College, Pa.

Sons of Martha; In University Halls, In Professional Practice, In Community Upbuilding, They Serve*

By W. R. WOOLRICH

Dean of Engineering, The University of Texas

About three years ago, the members of the American Society of Civil Engineers in planning a fitting celebration for the centennial of their origin sought out the proper officials in Washington and persuaded them to design and distribute a commemorative postage stamp that would pay fitting tribute to the professional engineers of North America.

The ready response of the Post Office Department was commendable but their judgment and knowledge of professional engineers came up short. As you will recall the first stamp issued was to the honor and glory of one Casey Jones!

Now all Americans enjoy the folk lore and the legends of the unusually rugged individuals who were so unique that they highlighted the parade of humanity in the growing up of our frontier states, and in this group we would pay homage to the recounted prowess of railroad engineerman Casey Jones. This does not, however, justify an authorized official of a great nation in making a selection of this driver of a throbbing locomotive as typifying the great contributions of the professional engineers of our nation for the current century of oustanding constructive accomplishments.

There are many millions of the people of this land to whom the professional engineers of America need to dramatize the high calling of professional engineering and of the commissioned registered engineer, without reducing the acclaim and the earned recognition that might rightfully belong to the enginemen, the surveyors, and the servicemen, these noncommissioned tradesmen that undergird the engineering profession in no small way.

It does give us reason to ponder, however, whether every technical man who has acquired eligibility for professional recognition in his state or province should not accept the privilege of acquiring a commission as a duly registered professional engineer in his state. This in itself will differentiate him from the noncommissioned tradesman within his community and commonwealth.

The Casey Jones commemorative postage stamp episode reveals, moreover, to the more than 400,000 professional engineers of the United States that we have done a poor job in defining the profession of engineering to an important segment of the American people.

In Rudyard Kipling's poem, "The Sons of Martha," dedicated to the Canadian Professional Engineers, we have a more enlightened interpretation of the engineer as he is envisioned in verse by that genius of adroit humor.

The Sons of Mary seldom bother
For they have inherited that good part
But the Sons of Martha favor their mother
Of the careful soul and the troubled heart

* Paper presented at the Allegheny Section meeting, ASEE, Pittsburgh, Pa., April 30, 1954.

And because she lost her temper once
And because she was rude to the Lord, her guest
Her Sons must wait upon Mary's sons
World without end reprieve or rest.

Legion are the professional engineers of this land who have given true fulfillment to Kipling's lines of appreciation. From George Washington to the newest recruit from our engineering colleges the men who have served and developed this nation might repeat with true pride that last paragraph of that scroll of the Engineer's Council for Professional Development which reads—

"To my fellows, I pledge, in the same full measure, I ask of them, integrity and fair dealing, tolerance and respect, and devotion to standards and the dignity of our profession, with the consciousness, always, that our special expertness carries with it the obligation to serve humanity with complete sincerity."

If we are to inspire by our ability and ardent desire to serve, may it be with some equity of emphasis within our homes, in the local community with its civic organizations, in the church of our choice and for our government as it might challenge the best that is within us. In these efforts we can serve our profession by example and by precept. With the writers of the old we can say, "He profits most who serves best."

Three Major Factors

The three major successful factors that place engineering as a distinctive profession apart from all others are (a) the ever recurrent demonstration of the abilities of its members to create the new, (b) the tireless devotion of the men of the profession to utilize what has been discovered for the betterment and advancement of mankind, and (c) the determination of the leaders of the profession to conserve and preserve with social and spiritual integrity the God-given resources of their homeland not only for the present but also for future generations. Briefly then, it is an engineer's mission to create, utilize, and conserve.

When you examine these three factors, they offer an advancing progression of opportunities. The "creative" originates with the most simple known values, then evolves into that which progressively becomes more complex. Each discovery just increases the possible permutations and combinations of more new inventions. It was the creative ability of early engineers that gave the profession its name. Engineur, from which Latin base "engineer" is derived, means "a genius of creative ability." The engineer's contribution in utilization sets him very definitely apart from the fundamental creative scientists such as the physicist, the chemist, or the geologist, in that the applications of scientific discovery for the usefulness of mankind is the engineer's unending pursuit. It is through his efforts that the fundamental science discoveries of the pure scientists finds an outlet and a usefulness in our world of industry.

But it is in conservation that engineering moves up into its highest effectiveness. The greater the scarcity and importance of a resource, the more certain the public can be, that the engineer, either by improved design, or by judicious substitution will determine economics that will extend the life of critical reserves.

It is of interest also that in his evolution, the engineer has risen through three distinctive stages of up-grading which we might designate as birth, growing up and maturity. In his first appearance, or birth, in world affairs, he was charged to create war machines for the ever-recurrent combats for racial survival. In this, he was not fulfilling his higher mission of creating, utilizing, and conserving, but was called upon to create, utilize, and destroy.

Historically, it is most fascinating to watch the cavalcade of these early creative mental giants as they broke through the crust of their distasteful heritage.

They moved into the second stage of their development as professional men of constructive ideals and became founders of civil life engineering by consecrating their talents, services, and genius toward useful designs and construction between wars. They began with such static creations as dams, aqueducts, bridges, and canals, then in subsequent generations moved up into the dynamics of production machines, steam engines, locomotives, and gas power—thence proceeded to areonautical flight and to metallurgical and chemical processes and are today in the front lines trying to direct the energy of the atom for a wide range of helpful applications.

In moving through these several advancements as civil life engineers, they experienced the third evolutionary stage of growing up as a profession. The advent of this final period has an American birthright. Strangely enough, it was ushered in by the Continental Congress of the United States when these three master minds, George Washington, Benjamin Franklin, and Thomas Jefferson set up the procedures and principles which guaranteed freedom of thought and action to the American people and then proceeded to implement a program of higher education to insure the conservation of our national resources by the educational process.

This third period which nurtured the engineering profession to maturity was ushered in by the organizing of Universities and Colleges for Engineering Education. Note that this was on American soil where freedom of constructive thinking and acting had been guaranteed by our national constitution based on democratic principles. Here in the United States the first university degrees for engineers of civil life were earned and conferred.

How well these three great men planned and spoke when they described the way in which this nation would make democracy work by setting up a system of of higher education that was yet unborn but that would be a guarantee and an insurance that this nation would thrive and endure.

Freedom To Act and Think

That the freedom of thought and action has produced excellent results is indicated by a reappraisal of the great inventions of the past one hundred years of the nations of the world. Of the one hundred greatest inventions of this period, the United States has more than her quota. A surprisingly large number of these were brought forth by transplanted Europeans who found the freedom of our nation a fertile ground in which to nurture their ideas. In the American quota of the greatest inventors, you will find such names as Steinmetz, Pupin, Baekland, Sirkorsky, and Zworykin. Each of them has revealed that it was the freedom to act and think in this country that caused him to transfer his affections from a native to a foreign home, and each in his turn has made a real contribution as great American citizens. Also during this same one hundred years of history, professional engineers have revealed their true capacity as men of ingenuity whose contributions to peace have far exceeded those to war. Every succeeding conflict reveals more and more dependence of nations upon engineering technology. The research scientist and the professional engineers are in the front lines of national defense of all modern nations when their freedom is threatened.

It is ironical that since the dawn of history, the engineer in times of war emergencies has carried the burden of defense for his fellow men as the creative genius of design, construction, processing, and in the management of men, machines, and materials. Whenever war clouds threaten, their fellow men urgently appeal to them to prepare the country for its defense but when the conflict is over these same engineers can expect to hear criticisms that are scornfully

derogatory of their war time contributions.

After each of our American wars, the professional engineer and applied scientist has ignored these poison darts of ingratitude and carried on with even greater responsive enthusiasm to rebuild, re-direct, and conserve the best that can be salvaged from each succeeding conflict.

This is the profession of which you and I are a part. We can be proud of the fact that the engineering profession has more to do with the conservation of our nation's resources than any other professional group. May we with equal humility recognize that in fulfilling our entire obligation in such a role we are only doing a small part of what this opportunity offers.

To be more specific, all of our nation's resources can be divided into three types (a) natural, (b) education and equipment, and (c) social and religious. It is in this higher trinity of our professional relationships that we should be most concerned.

For several generations, the Christian Associations have used as their symbol the equilateral triangle with the three sides labeled "Spirit-Mind-Body." May we, as professional engineers, look upon our triangle of resource conservation as being made up of three types of national resources, namely, natural resources-education and equipment—and our social and religious ideals. In this you have the picture of our higher trinity of opportunity in conservation.

We are vitally interested in the conservation of our natural resources which include materials, energy, and men. This represents one side of our triangle. In periods of abundance, the human being becomes most wasteful of these and dissipates them with wanton recklessness.

As a national example of our material wastefulness, it is not too far back for most of us to remember the shameful mis-use of our forest resources. Only yesterday, did we become concerned about our soils and our phosphate reserves, and only today are we tightening up on our natural gas reserves.

In energy reserves, the price of fuel had to rise to high levels before we could convince ourselves that it was wasteful to let the energy of our rivers go to waste. Yet all of the time we recognized simultaneously that our fuel resources were depletable and that water power energy must for the most part be used when it is available for the more we use it for power development the less damaging by floods it would be on its way to the sea.

Conservation of Men

In the conservation of men, only the free nations have held any high appreciation of the dignity of man. The early examples of dictators creating some giant task like the pyramids to keep slaves out of mischief, or the Roman games to reduce the number of Christian believers, or the Crusades to arouse a loyalty of restless subjects to certain barons or the more recent exhibits, first in Germany and now in Russia, of human extermination to make the world safe for the privileged few—these should make us pause in appreciation of the Bill of Rights of the United States or the Magna Carta of Great Britain.

As engineers and creative scientists, we can point with pride to the National engineering societies for the part they played in giving the human factors in management a front place in their past twenty years of endeavor. Both from statistics and from personal observation, the speaker is convinced that Great Britain and western Europe trail far behind the United States in their attempts in the management of men.

If we look next to the second leg of the resource triangle and recount the engineers' contribution in developing this second resource—education and equipment—we find a close mutual relation-

ship. It has been by education that engineering arose to maturity as a profession and it has been the scientist teamed up with the engineer that has made the world's greatest contribution in the design of equipment and tools of production.

When we as men and women observe that civilization itself had more natural resources during the cave man period than exist today, yet that in food, rainment, and shelter the cave dweller possessed only the most crude necessities, then we can more greatly appreciate this evolution of man by his creation of tools and his education in the knowledge of how to use them. In this evolution, appreciation for art, music, and the sciences are all a part. The engineer's portion of this cavalcade of progress has been primarily to solve those most difficult problems that required scientific analysis and inventive development.

The third log of our triangle—social and religious ideals, is probably the resource which engineers have been prone to overlook as not belonging in their sphere of activity. Thank God engineers are today moving into the center of it where they belong.

If this nation would retain its position of leadership, more technically trained leaders with dynamic courage and unimpeachable integrity must accept the obligations in the fields of human engineering, civic righteousness and high level statesmanship.

The reputation of engineering education in North America has been established primarily on the productivity genius of our American engineering college graduates. Europe and Asia recognize us for this genius in production. A large segment of our registered professional engineers of the United States and Canada belong to the group of graduates who have earned their professional status by production, operation, construction or management.

The engineering sciences must be advanced in most engineering curricula, but this should not be at the expense of our accomplishments in industrial engineering and management. All western Europe and much of Asia are determined to try to overtake us in industrial activity. We should not reduce our rate of advancement in industrial engineering but raise the level of what we have in that field as well as direct our attention to new high levels of accomplishment in the engineering sciences.

Greatest Task Ever Given To Mankind

Since the dawn of history whenever the moral and spiritual fiber of a people shriveled up, they have been overpowered by their adversaries. At the present moment this nation is confronted with the greatest task ever given to mankind. The world over we have democracy being challenged by a philosophy of communism. The professional engineer and the scientist are and should be right in the midst of the present international action. Those who will accept the challenge with a complete concern and devotion to the higher instincts and convictions of their being will come forth as greater professional men and citizens than civilization has ever yet produced and as creative scientists, conservationists and professional engineers, let us not forget which of these resources controls the rises and the falls of our civilization.

It would be well to digress briefly and examine our obligations as engineering teachers to the engineering profession and then in turn examine the ways in which the professional engineer can work more effectively with the engineering colleges, in a concerted program of resource conservation and human betterment.

Much has been said about increasing the number of business and humanities courses in the curricula of enigneering. As a Dean of Engineering, I can report from experience that a fortnight seldom passes that some ardent progressive pro-

moter does not urge that we add just one more course to our already overloaded program. Most engineering curricula today require as much work for a Bachelors Degree in Engineering as is required in the same institution for a Master of Arts and most of us are aware that each course in engineering is a more rigorous discipline than those in the Arts degree plans.

The first responsibility of a College of Engineering is to produce graduates who can qualify in their own field of specialization. You cannot dilute the curricula beyond certain minimum standards and still have a man acceptable to the Registration Boards of the states and provinces of North America.

The survey made in the State of Pennsylvania in 1938 by Dr. Learned gave interesting evidence that the product of our engineering colleges is far above the average in cultural attainment. Yet the proponents of general education are trying to make the world believe today that something should be done to save the souls of the men who are educated in the specialized professions, especially engineering.

Recently, a poll was made of the men and women of Chicago who had made the greatest contribution to that city by their lives of usefulness and preeminent services. When the tabulation was completed nearly seventy per cent of those selected were from the professions. When you consider that the proportion of college graduates in Chicago with a Liberal Arts College education outnumber those with a professional school education, it would seem that our general education friends need to make a new appraisal of their philosophy of life preparation.

The present trend is for the industrialist who employs science and engineering graduates to provide a program of expected reading and self development in the areas related to business, to management and to cultural betterment. The recent reports from a large segment of American industry to the Committee on the Evaluation of Engineering Education approved the proposal that universities should devote a full measure of any available time to improving the level of scientific education of their degree candidates that industry should then take the ball from there and give a complementary education in business training, management and public relations.

Those of us responsible for teaching the rigorous disciplines of engineering might gather some solace from the poet's pen when he wrote:

> Good timber does not grow on ease
> The stronger wind, the tougher trees
> By sun and cold, by rain and snows
> In tree or man, good timber grows.

Personally, I have full confidence in the professional engineer as a product of our American engineering colleges being ready to take his place in the complex life of our nation.

The urgency of the hour does demand that each of us must take our share of responsibility to be complete professional engineers and assume our full obligations in conserving not only our "natural resources" or our "natural resources and tools and equipment"—but we must go all of the way and claim our place in the civic, and cultural and the religious activities of our community, our state and our nation.

And let us not overlook the fact that the financial capital of the world has moved to the American continent and that this has happened within the two past decades. This also in turn places increased obligation upon our international stewardship of wealth.

Our natural resources might deplete a small percentage of the total from year to year but such depletion, except in case of all out war, will happen very slowly. Our education and equipment will generally be an advancing resource, but our social and religious philosophy is a less predictable variable and let us re-empha-

size again it constitutes the controlling force in this resource trinity.

Blue Print For Advancement

In closing may I bring this talk down from the general to the specific. As a blue print for the advancement of the professional engineer for the decade immediately ahead might not our educational program include a cooperative assumption of responsibilities on the part of each of us. Such cooperation should include both educators and practicing engineers as presented herewith:

As individual teachers in the classroom that we will:

1. Inculcate high regard for safety, ethics, and public and community service and responsibility in every major engineering course.

2. Give increased emphasis to creative thinking in each engineering course and encourage men of creative ability to attempt the unusual.

3. Encourage the man with a high level of engineering ability to carry on through the Master's degree.

4. Give encouragement to the geniuses among us to move to the Doctor of Philosophy degree. These would usually be the proven men with an Army General classification score of 130 or above.

5. Participate whole heartedly in the community and professional life of which we are a part.

As administrators in engineering colleges:

1. Aim towards an up grading of the quality of students pursuing engineering in order that we may more certainly justify full professional recognition of engineers among the profession.

2. Maintain a high level of the engineering sciences and mathematics as a core to all engineering programs.

3. Extend the recruiting efforts to the rural high schools where the percentage entering college is usually low. This may provide a net increase of 10 percent of graduating engineers of high quality and ability.

4. Develop more short term advanced engineering courses of graduate level to enable men of the profession to acquire knowledge of the new advances in engineering science and technology to keep abreast of the more recent graduates.

5. Encourage all engineering teachers to quality for registration in their respective states.

6. Encourage every engineering teacher to engage in current engineering practice during his spare or summer vacation periods so long as it does not interfere with his teaching obligations and also that he conform to salary schedules equal to or above those recommended by the profession.

As practicing engineers in the profession:

1. Maintain an alert guardianship of the profession against an enforcel leveling of the individual by engulfing graduate engineers in unionism.

2. Encourage more employers to improve the spread of salaries to show a full recognition of years of competent high level service.

3. Expand the current trend of employing companies to give further education in management, in sales and in cultural reading assignments to supplement the technical and scientific education of the college.

4. In each state press for a fair proportion of engineers and industrialists on the College and University Boards.

5. Improve the necessary procedures to afford greater recognition of engineers in public and national life.

6. Encourage the registered engineers of North America to campaign for a level of engineering teachers' salaries in each state and province equitably adjusted to comparative levels with law and medicine.

Nationally our march of progress

should envision an America growing deeper in its scientific, cultural and spiritual foundations, fully capable of directing the distribution of our financial resources through a personnel well educated in the principles of science and engineering from the basic fundamentals to their various applications. These scientific principles should be effectively applied to the management of men, the development of power, the utilization of materials, the transportation of man and the distribution of his goods for the benefit of the human race. I predict that as true "Sons of Martha" we will meet this challenge.

Experiments Invited for Taylor Memorial Laboratory Physics

The American Association of Physics Teachers is undertaking the production of a book of Advanced Undergraduate Experiments in Physics, as a memorial to the late Lloyd William Taylor. The material is being supplied by the teachers of such laboratory courses; some one hundred physicists have contributed experiments and suggestions. In spite of this fine response, there may be many other interesting and illuminating experiments yet to be contributed, and these experiments also should be included in this book, to give them wider circulation and thereby to enrich the instruction in advanced physics courses. Every effort is being made to obtain them.

Although the primary responsibility for this book belongs to A.A.P.T. members, contributions are cordially invited from all physicists and from colleagues in other sciences, outside the United States as well as inside. All fields of physics are represented. Informally written notes, or laboratory instructions as used by students, are quite satisfactory, since the editors must pull all material into publishable form. To be of use these experiments must reach the editors not later than March 1, 1955. They may be sent to T. B. Brown, The George Washington University, Washington, D. C., or to the appropriate editor. Sections and editors are—*Mechanics:* R. H. Bacon, 405 Bedford Road, Pleasantville, N. Y. *Heat:* R. L. Weber, Pennsylvania State University, State College, Pa. *Acoustics:* L. R. Weber, Colorado State College, Fort Collins, Colo. *Electricity and Magnetism, Electronics:* M. C. Harrington, Drew University, Madison, N. J. *Optics:* H. A. Nye, Cornell University Aeronautical Laboratory, Buffalo, N. Y. *Atomic Physics and Spectra:* S. C. Brown, Massachusetts Institute of Technology, Cambridge, Mass. *Radioactivity and Nuclear Physics:* R. R. Palmer, Beloit College, Beloit, Wis.

Opportunity Unlimited—Some Observations About Tomorrow

By HOWARD E. FRITZ

Vice President in Charge of Research, B. F. Goodrich Company

In a final Doctor's oral examination, I was asked why I had returned to school to acquire the Doctor's Degree. I answered, "To insure a larger income," and promptly flunked. I was told later that the proper answer was, "To broaden my horizon." I was talking about a different horizon. Mine was the financial, their's the great blue yonder. I finally came to the conclusion that the more arguments won, the fewer friends there were, so I lost this one and passed the exam later. That is a pretty good lesson in psychology for all, because by losing one battle, we do not necessarily lose the war.

Later, it was brought forcefully to mind that there is a small minority of people who work diligently without regard for the needs of humanity or ultimate financial rewards. These people are usually termed *Fundamental Scientists* who dig into nature's crust for more information and knowledge relative to the natural laws, the Researchers. They are really your partners, for they very often push back the veil of ignorance a little farther and a whole new world stands before them and their partners, the *Applied Scientists.* You fellows fit into this last group, for your job will be to search for things pertaining to human needs. You will take the basic information and really go places with it.

Philosophers of an earlier day would be astounded to see that it has been business people, not the social reformers who have condemned and destroyed the status quo. This is not to deny that scientific discovery is the raw material of our advances, yet science alone, invention alone, could not have accomplished all this. It had to be brought down from the clouds to join the service of men and women through industrial development. If we are to continue our rate of progress, we are going to need lots of bright, young people coming into business for the years hence.

Research without interest from the applied people is pretty drab. There is no stimulus to a researcher as valuable and inspiring as an expression of interest from the commercial divisions.

Think of the marvelous machines, processes and products and, as a matter of fact, civilizations, created through the application of the fundamental laws.

We are standing at the limitless frontiers of thinking: power, electronics, chemistry, metallurgy and engineering—all these sciences that are giving us the power and ability to dig into the crust of nature and wrest her secrets from her. Research is the challenge of the times; science is the new competitive weapon. It is the typically American answer to providing more jobs and better things.

The future of our civilization depends upon the ability of our engineers and scientists to disseminate information representing the true technological facts, thus promoting a better understanding of the role and the place of science and technology in our national life. It could be that some of us may live to see the day when a nation's true wealth will be measured in terms of its men and women

of science rather than in terms of its natural resources.

May I caution you that this world is not filled with nice people. It is a fact that as many people go to a contest to see the champion get knocked out as to see him win. Bob Fitzsimmons, the one-time heavy-weight champion of the world, was heard to say: "There are only two kinds of people on earth—Fighters and Quitters." There may be something to that remark when analyzed basically: Those who won't be beaten no matter what the obstacle, and those whose life is one series of hard luck episodes after another. One gains more experience and courage out of a good whipping from a champion than he does in any victories over mediocre opposition. This is just another way of saying that your early failures should be considered in the light of valuable assets for future undertakings. But if you permit past mistakes and failures to fill you with fear, a grudge against the world and loss of confidence and initiative, you will surely strike out the next time the chips are down.

You could get yourself into the same frame of mind as the cannibal who, just after the jungle party dinner said, "I get so fed up with people sometimes."

Research is Both Constructive and Destructive Force

To better assess the tomorrows, let us dwell a bit on past accomplishments.

It does not require much study or investigation to find that research is the greatest constructive as well as the most destructive force that mankind possesses and controls, bar nothing.

This destructive force is very real. There is no force which can be as deadly to an established business as industrial research. No war, no panic, no bank failure can so completely and irrevocably destroy a business as a new and better product in the hands of a competitor.

The history of modern business is packed with instances where a well-established, well-managed, conservative business has gone into bankruptcy or disastrous reorganization because a competitor has entered the market with a new or better product. Here are a few cases in point:

"In 1850 there were over 2500 miles of canals completed or under construction in the United States. Nearly a thousand additional miles were projected . . . over 150 million dollars had already been invested in this business. In terms of national wealth, this presented a proportionate investment equal to an expenditure of approximately seven to eight billion dollars at the present time. . . .

"In spite of all arguments in 1860 the canal was dying. . . . The total loss to the states was over a quarter of a billion dollars. . . . The indirect loss was surely much greater as the default of the canal bonds was one of the causes of the Panic of 1856.

The railroads came and prospered, and in 1910 the railroad executives said, "Now we have a prefectly safe business. No outside competition can touch us; all we have to do is to sell more bonds, build more railroads, collect more profits. There can be no competition to a railroad except another railroad; The experience of the canals proved that. . . .

"Now, of course, in 1910 our railroad executive was aware that some 'crackpot' mechanic, out in the Middlewest, had invented a gadget called the automobile. Being a sporting fellow, and interested in all things mechanical, our railroad executive owned one himself. Occasionally he even attempted to drive down town with it on a Sunday afternoon when he had lots of time, that is, if the weather was favorable. But to imagine that these monstrosities would ever compete with the pullman car was as absurd as that fool report that two bicycle repairmen out in Dayton had learned how to fly. . . .

"In 1910 the market value of the stock of all-American Railroads was 8.3 billions and the value of the bonds about

12.0 billions—20.3 billions total. . . . Yet in 1940. . . . The market value of the railroad bonds was less than 8 billions, and our railroad executive. . . . Could have bought on the open market the complete stock ownership of the American Railroads for 2.2 billions of dollars." 10.2 billions. Technological loss approximately 10 billions.

The technological loss is directly chargeable to the research laboratory, or more fairly, to the management which failed to insure against this loss.

The railroad and canal industries are not isolated cases. There is hardly an industry which does not afford illustrations of the destructive power of research. The cotton industry, for example, where synthetic fibers (rayons, nylon, etc.) are to a large extent chargeable with the economic loss represented by the distress of the cotton industry; the whale-oil industry replaced by coal oil, replaced by gas lighting, replaced by incandescent lights, replaced by fluorescent lighting. The old solid truck tire is gone, replaced by heavy-duty pneumatics; water-dispersible paints are here to stay; fast-drying lacquers lowered the cost of automobile finishes—all representing a loss to someone. Signs on the present horizon—Television Vs. The Movies.

This is the law of research: "Every new product produces wealth greater than it destroys." For the human need or desire which made it possible for the new to displace the old gives to the new a greater market than the old ever enjoyed.

Let us always remember that there is nothing so perishable as an established product, and that stupidity and pessimism are no defense against the impact of a new idea.

The frontiersmen who settled this, your country, risked their lives in the winning of it from the untamed forces of the wilderness. You and I are the frontiers-people of today and the frontier of today is just as ruthless, but different in that the big advances are to be made through the frontiers of thinking. Our country was founded by men and women who turned their backs on the past and placed their faith in tomorrow. Our industrial strength today is the result of that faith which has existed throughout the years in plowing back portions of today's earnings in order to insure tomorrow's opportunity.

New pursuits always involve new risks. New ventures are full of uncertainty, but the American process has always been to face boldly the risk and uncertainty and to direct a course though freedom to prosperity. Remember, you cannot steal second base and keep your foot on first base. Free men, given opportunity, make their own security, for as long as they are free the game is worth the candle and they can afford to try and try again until they succeed.

Here, then, in science and research is insurance for all of us, insurance not only good for now—it is good for all time, because the free and fertile mind, through research and development, creates more employment, more security, and higher standards than any known process.

This is the only kind of insurance that will sustain us as free people and perpetuate the process of liberty in the great competitive race for survival among nations.

Today's Frontiers of Thinking

What are today's frontiers of thinking? Here are some of them:

(a) Artificial rain-making—Not sure about validity of making rain, but artificial snow-making sure. The great snowfall in California in 1951 was a seeded storm. A great boon to irrigation where run-off water is involved.

(b) Utilization of solar energy. This must be done. We have only 300 years to go before we are out of all kinds of fuel presently commercial. Energy from

the sun is about equivalent to 1 Hp per square yard. The sun's rays shining on a single square mile of earth's surface have energy equivalent to that of one atom bomb of the type exploded at Hiroshima and Nagasaki.

(e) Guided missiles and rockets. They are here today to stay and are already staggering us with problems for new and better materials for the speeds and temperatures which will prevail in their use.

(d) Electronics and the electron. We are in the midst of a push-button and electronic era. The electron which is a unit of bouncing, darting electricity, which man is able to control, has wrought spectacular changes in the everyday life of everybody. It makes possible individual two-way radio systems, has sharpened our five senses, given us television and the electric eye. Science is on the march. This is only an index of what is to come.

(e) Viracides—One of our own products, beta-propiolactone, shows great promise as a viracide; could be that we shall help solve the problem of the common cold and influenza. Looks very good.

(f) Titanium—A light, tough and corrosion-resisting metal. One ingot of titanium at $7.50 per pound costs more than a cadillac automobile. Sheets and strips of the silvery gray metal are selling for $30,000 per ton. Yet industry is begging for more of it.

(g) Atomic energy—The splitting of the atoms of uranium 235 has been used to convert the abundant uranium 238 to plutonium for chain reactions, but the amount of fissionable material produced (plutonium) has always been less than that used and the primary uranium 235 was therefore eventually used up. The conclusion in our time of breeding experiments would make it possible to produce from fertile materials more fuel than is used. Thus, natural uranium would become, in effect, additional sources of fuel for the nuclear reactor.

Just this past week at a meeting of the national conference board in New York, it was announced that the breeder reactor was now an assured fact. This great discovery will now provide society with additional sources of energy, twenty times that of our known oil and coal reserves.

The use of radioactive isotopes poses two very serious problems to those who may be privileged to work with them:

1) The fear that they may become sterile.

2) The worry that they will *not* become sterile.

(h) The hydrogen or "Hell" bomb. No peace-time use has as yet been conceived for this development. In any event it has far-reaching implications as regards the social problems of nations.

However, if science and research can devise methods of controlling this thermonuclear reaction, the fuel and energy requirements of man can be satisfied for many, many centuries.

(i) Space travel and the earth satellite —Collier's issues for March and October, 1952. The amazing thing here is that these things relative to space travel are in the cards and fully feasible. The comic books of 16 to 20 years ago have hit the jackpot.

Not long ago, a young test pilot named William Bridgeman made history. In a needle-nosed 40-foot long rocket-powered plane, he reached the incredible altitude of 79,494 feet (about 15 miles) above the earth's surface while traveling at twice the speed of sound—1238 miles per hour. I am proud to tell you that it is my privilege to know this young man well. We have exchanged views on many subjects together.

Bill Bridgeman at that time had flown higher and faster than any human. At an altitude of 79,494 feet, for all practical purposes, 96% of the earth's atmosphere was below him. He had actually reached the borders of space. The flight though it lasted only a few minutes,

marked one more advance in man's progress toward conquering space.

As a result of this flight, another experimental plane capable of reaching an altitude of 200,000 feet (about 37 miles) and with a speed of 1800 miles per hour is being built, according to a recent announcement.

Many lives will be sacrificed in this effort, just as for the steam engine, electric motor, the railroads and airplane.

The subject of space travel has been termed "Crossing the Last Frontier." With this I disagree, because before we get out of this great problem, we will find ourselves in another still more difficult one. I am only saying there is no last frontier.

Our engineers and scientists feel that they know how to build and operate a station in space that would circle the earth at a speed of 4.4 miles per second, 15,840 miles per hour, around the earth once every two hours, and 1075 miles up. The job would take 10 years and cost twice as much as the atom bomb ($4,000,000,000). The peculiar feature of this undertaking is that it would not use atomic energy in the project. At an altitude of 1075 miles, outside the influence of earth's gravity, everything would be weightless including men and women (a brand new reducing formula) so everything would float in space. There is no air to provide oxygen or carry sound. All people would work in pressurized space suits, provided with small rocket motors, and have a safety line secured to the space station. Fantastic, but a potential reality.

Thirty years ago all of these things were given little or no place in our thinking. Today some of them constitute a highly desirable volume of sales and profit. Yesterday's products of research and development. Perhaps I have left you in a state of confusion, but I am no more guilty than the professor who had taken his students all through the texts in their four-year medical course. At graduation time he called them together and said, "Now that you have finished your course, I want to tell you one thing more. Half of all I have taught is wrong, but the trouble is I don't know which half."

This is probably true of most of the "knowledge" that we accumulate in the course of our formal aducation. From thereon, our true education begins—To unlearn the wrong half.

Challenges of Tomorrow Are Staggering

The people who make this economy tick, as I have said before, are our scientists—Your Partners—and we all are proud of them and their accomplishments. Many times in history you and they together have materially lessened the burdens of mankind, helped create a new and better civilization and contributed to the dignity and well-being of this great country.

Recent studies indicate that the total population of the United States by 1960 would be 174 million people, an increase of about 15 per cent from 1950. This population increase will be mainly an addition to the consuming group rather than to the producing group. Those at work will be faced with the task of supporting a much larger number of people than in any previous period in our history.

But in achieving more productivity, every American worker must be provided with more effective tools. These tools will cost an enormous amount of money—$200 billion worth. Compare this with the $71 billion spent for new plants and equipment in the 1920's, or with the $110 billion invested by industry in the 1940's when this country built an undreamed of productive capacity for war and peace.

An increase in population is not necessarily a stimulant to business. Today, more people in India and China might simply lead to more starvation.

But the situation in the United States is quite different. With our competitive economy, our abundant natural resources, our technical facilities, and our substan-

tial "know-how" for producing goods and services, increases in population can exert a stimulating effect on business. These are some of the new and limitless horizons.

The challenges of tomorrow are staggering. The cloak of complacency, if any, must be discarded. Ingenuity, resourcefulness and persistence must be our watch words.

To survive, grow and prosper, we must recognize and dispose of these responsibilities:

1. If we expect to better our situation in the future, let alone feeding, financing and rebuilding the rest of the world, we must contribute the necessary new and better things to keep every mill, every mine and every farm turning out useful and needed products. Because products, not dollars, are wealth.

2. The new things to come have been splashed across the pages of newspapers and magazines and broadcast over radio and TV, dangerous and exaggerated to be sure, but many of them are here now and there are many more over the horizon. We must have our just share of these innovations and we will only get them by an all-out team effort of cooperation and determination.

They could be fabulous.

3. If there is any one thing we must reckon with it is the fact that we will be in a constant state of constructive change. The American people have gotten into the habit of expecting more for less and in the end they always get it. If we are prepared for and tolerant to the changes that must come to our products and processes, we will meet these challenges head on and emerge with a whole skin.

4. Cracking the crust of nature for new knowledge and new ideas is a difficult, tedious and discouraging process. But if we can continue to have your support and encouragement, progress will be made, and, as I see it, the future will be a good place in which to live.

To me the most satisfying reward in this life is the joy of accomplishment, and accomplishment can best be attained through the efforts of a great, well—integrated society—all of us together.

Let us pledge ourselves here and now to keep the fires of creative research burning and the wheel of prosperity and plenty spinning in our time.

In the News

The Institute of Statistics at **North Carolina State College** is sponsoring a nine day intensive training program in Statistical Methods for Research Workers in Industry and the Physical Sciences starting January 22, 1955 and running daily (including Sundays) through January 30, 1955. The course is designed to make available to research workers in industry and the physical sciences the new and powerful statistical techniques of data analysis and experimental design. Guest lecturers will include W. J. Youden, Statistical Engineering Laboratory, National Bureau of Standards; Carl A. Bennett, Hanford Works, General Electric Company; and Cuthbert Daniel, Statistical Consultant, New York City.

A registration fee of $100.00 will be charged and enrollment will be limited to the first fifty qualified applicants. For further information write to Institute of Statistics, North Carolina State College, Box 5457, Raleigh, North Carolina.

The Importance of Dependable Approximation Methods in Nuclear Engineering*

By CHARLES F. BONILLA

Professor of Chemical Engineering, Columbia University

It is now evident that continued progress towards economical nuclear power will require many new concepts, variations, and improvements in reactors, along with the painstaking computations necessary to check that no part is overheated nor overstressed. Although physicists and mathematicians have done much of such work to date, as their interest passes on and as more engineers become familiar with the field, the burden of these designs and consequently the advancement of nuclear power falls more heavily on the engineers' shoulders.

Rough data and approximate methods are characteristic of the field at present, as witness the uncertainty in many nuclear cross-section values, the one-group neutron diffusion theory, and the unreliability of most shielding and thermal stress calculations. However, these instances are approximations which had to be obtained so that design could go on.

The young engineer entering this field will soon learn and appreciate these specific procedures, but in general he is not taught to use nor, in particular, to originate approximate methods on account of the emphasis on precision and elegance in our mathematics, physical science, and engineering courses. I therefore wish to emphasize that approximation methods should be duly included wherever appropriate in the courses in engineering curricula, and certainly for engineers going into the nuclear field. These

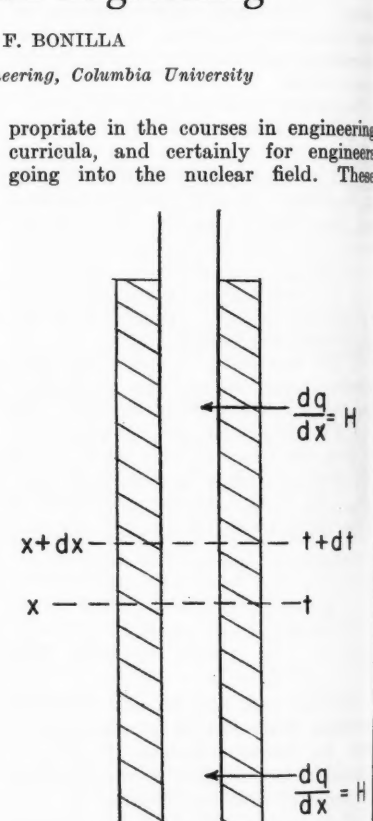

FIG. 1. Coolant flow through metal with heat generation.

* Presented at the Preliminary Conference, Summer Institute on Nuclear Science in Engineering Education, Columbia University, April 24, 1954. Contribution No. 47 from the Chemical Engineering Laboratories, Engineering Center, Columbia University.

methods include, in general, graphical and numerical integration of differential equations, and in particular incremental and relaxation methods for the solution of steady and unsteady state problems in fluid flow, heat transfer, neutron diffusion, gamma ray generation and absorption, stress and strain computation, etc. An exhaustive list of such methods will not be provided here—a word to the wise is sufficient, as each teacher is well able to dig out and present such methods if he is made aware of their practical importance. Instead, an example in which such a method proved valuable in reactor design will be outlined.

Example

Assume a channel filled with liquid metal coolant in a nuclear reactor at temperature $t = 0$. At time $\theta = 0$ coolant flow at $t = 0$ is suddenly started and the surrounding metal begins simultaneously to generate heat at constant rate H per unit length. It is desired to find the temperature history along the channel, for stress calculations. L/D is large and for simplicity it may be assumed that at any distance x along the channel from the inlet the temperature in the liquid metal coolant and cooled solid metal is uniform at t. The situation is as shown in Fig. 1. The heat capacity of the solid per unit length may be designated m_s and of the coolant m_c, and the coolant average linear velocity $\bar{u}$.

When flow starts up it will take some time (call it θ_1) for the coolant that was not initially in the channel to first reach any position x. Evidently

$$\theta_1 = x/\bar{u}. \tag{1}$$

Before time θ_1 all of the coolant to pass x was in the reactor (and thus being heated) all the time since $\theta = 0$. After θ_1 the coolant passing x was *not* in the reactor (and being heated) all of the time since $\theta = 0$. Thus a change in slope of t vs. θ seems reasonable when θ_1 is reached at any location.

Before θ_1 a heat balance yields

$$H\theta = (m_s + m_c)t. \tag{2}$$

At infinite time a steady state will have been reached such that

$$Hx = \bar{u}m_c t_\infty. \tag{3}$$

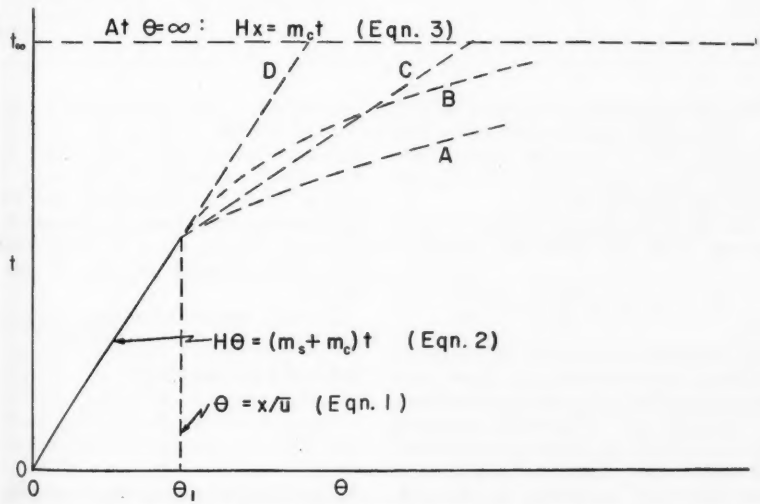

FIG. 2. Temperature variation with time at position x.

TABLE I

CALCULATIONS FOR REACTOR START-UP

θ \ $x\rightarrow$	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
0	0	0	0	0	0	0	0	0							
1	0	20	20	20	20	20	20	20							
2	0	30	40	40	40	40	40	40							
3	0	35	55	60	60	60	60	60							
4	0	37.5	65	77.5	80	80	80	80							
5	0	38.75	71.25	91.25	98.75	100	100	100							
6	0	39.38	75.	101.25	115.	119.38	120	120							
7	0	39.69	77.19	108.13	128.13	137.19	139.69	140							
8	0	39.84	78.44	112.66	138.13	152.66	158.44	159.85							
9	0	39.92	79.14	115.55	145.39										
10	0	39.96	79.53	117.35	150.47	175.39									
11	0	39.98	79.74	118.44	153.91	182.93									
12	0	39.99	79.86	119.09	156.18	188.42	212.93								
13	0	39.99	79.93	119.47	157.63	192.30	220.67								
14	0	40.	79.96	119.70	158.55	194.97	226.49	250.67							
15	0	40.	79.98	119.83	159.12	196.76	230.73	258.58							
16			79.99	119.91	159.48	197.94	233.74	264.66	288.58						
17				119.95	159.69	198.71	235.84	269.20	296.62						
18					159.82	199.20	237.28	272.52	302.91	326.62					
19						199.51	238.24	274.90	307.71	334.76					
20							238.87	276.57	311.31	341.24	364.76				
21								277.72	313.94	346.27	373.00				
22									315.83	350.11	379.63	403.00			
23										352.97	384.87	411.32			
24											388.92	418.09	441.32		
25												423.51	449.70		
26													456.60	479.7	
27														488.15	
28															518.10

These three equations are shown on Fig. 2. The intermediate portion connecting equations 2 and 3 remains to be determined. Four possibilities A, B, C, and D are qualitatively shown.

For the intermediate period, a heat balance yields the differential equation

$$H = (m_s + m_c)\frac{\partial t}{\partial \theta} + \bar{u}m_c\frac{\partial t}{\partial x}. \quad (4)$$

The engineers working on this problem were not able to obtain any direct solution of equation 4 by the usual methods of calculus and differential equations (however, it can be solved by operational calculus). One difficulty is that only one boundary condition is clear-cut, namely, that when $\theta = \theta_1$ by equation 1, $t = H\theta_1/(m_s + m_c)$ by equation 2. The slope of the intermediate position is not definitely known at θ_1 and neither the slope nor θ is definitely known at t_∞. It may be noted that equation 2 (line D in Fig. 2) obeys equation 4, but seems to be a trivial solution, since it gives $(\partial t/\partial x) = 0$, which is clearly incorrect by equation 3.

The only method of solving equation 4 that was hit upon yielded the line

$$H(\theta - \theta_1) = (2m_c + m_s) \times \left[t - \frac{t_\infty}{1 + \frac{m_s}{m_c}}\right]. \quad (5)$$

This is similar to line C, Fig. 2, and satisfies the intuition that a change in slope

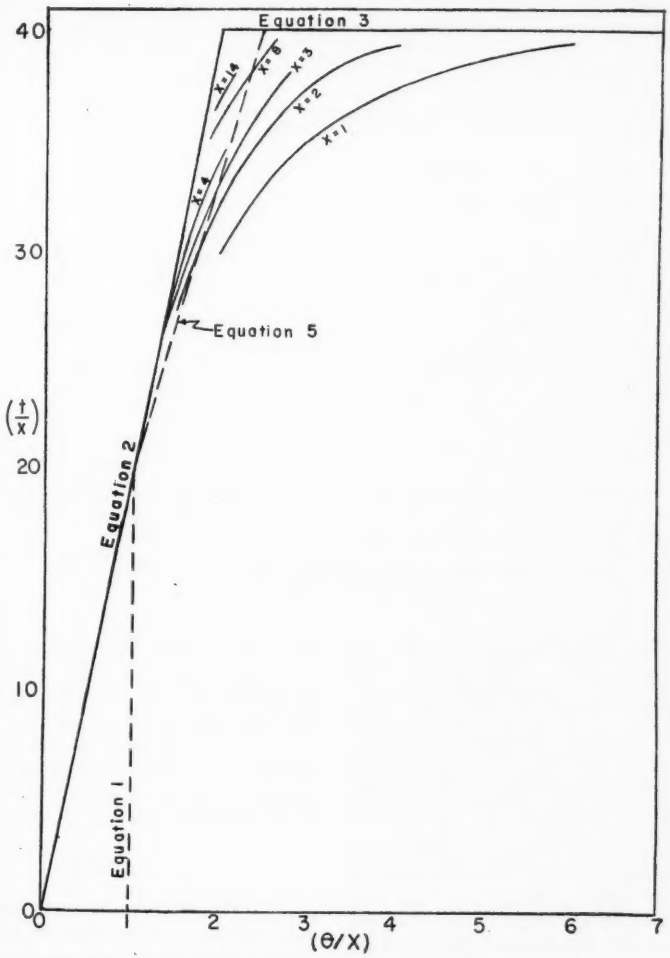

FIG. 3. Generalized plot of specific illustration of reactor start-up.

should occur at θ. (At the time it was not noticed that equation 5 with θ_1 and t_∞ replaced by equations 1 and 3 does not quite satisfy equation 4.) However, the solution was not entirely convincing, and a finite increments solution was employed as a check.

This problem was worked for the following numerical values: $\Delta x = 1$, $\bar{u} = 1$, $\Delta\theta = 1$, $H = 10$, $m_s = 0.25$, $m_c = 0.25$. The selected sequence of events was:

a) During each $\Delta\theta$ the fluid is stationary, and fluid and solid heat up by $\Delta t = H/(m_s + m_c) = 20$.

b) Between intervals the fluid suddenly moves the distance Δx adiabatically, then the solid and liquid temperatures equalize.

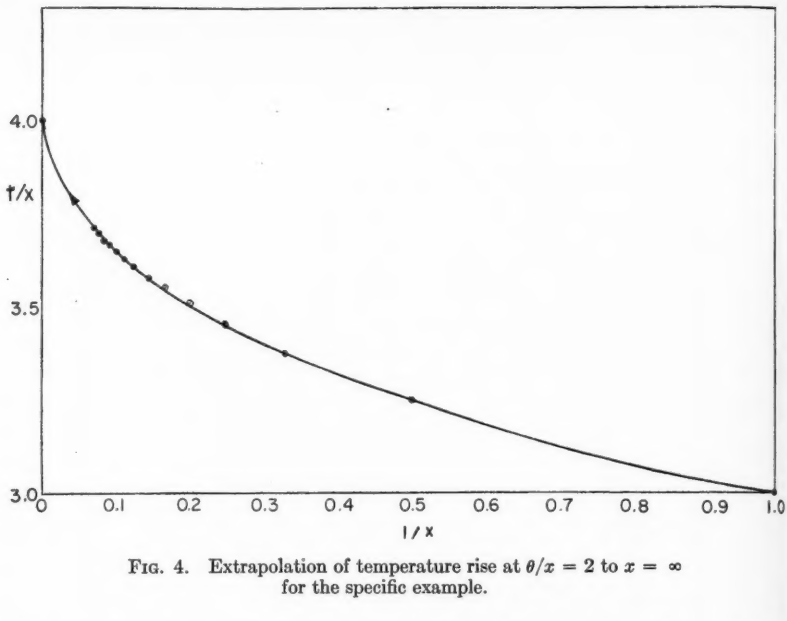

FIG. 4. Extrapolation of temperature rise at $\theta/x = 2$ to $x = \infty$ for the specific example.

For each $\Delta\theta$ the process in each Δx thus consists of averaging the solid temperature and the adjacent upstream liquid temperature and adding 20. The numbers obtained are shown in Table I. The process was simplified by the fact that the temperatures at $x = 2\theta$ (underlined) are obtainable by adding 30 to the temperatures at $(x - 1, \theta - 1)$.

By dividing equations 1, 2 and 3 by x it is seen that a generalized solution in terms of (t/x) and (θ/x) is possible. This is shown in Fig. 3. The increasing numbers of increments thus become closer and closer approximations to the exact solution, with an infinite number of increments for a finite case, or infinitesimal values of $\Delta\theta$ and Δx. Curves obtained for up to 14 increments of x are shown in Fig. 3. Figure 4 extrapolates (t/x) at $(\theta/x) = 2$ to $1/x = 0$ or $x = \infty$. It is evident from these figures that the correct solution is a straight continuation of equation 2 to equation 3, even though intuition indicated a change in slope at θ_1. Thus a finite increments method has yielded with little trouble a reliable answer when an analytical and intuitional approach failed.

Conclusion

It is my opinion that most engineers on a problem such as this would employ only the analytical approach, would be uncertain of the best attack, and after considerable effort would not obtain the correct result; whereas with only a small amount of training in approximation methods they would have encountered no difficulty.

Training Engineers for Research*

By CHARLES E. BALLEISEN

Southwest Research Institute, San Antonio, Texas

Whether we train engineers for research or whether we select them for it, I am not certain, but I want to point out right here at the beginning that we should train engineering students for Research, or for Sales, or for Manufacture, or for Design, and not for automotive work, aircraft, transportation, refrigeration, power production, or similar trades. We must realize that, in the past few decades, engineering has lost a great deal of its former empirical nature. At the turn of the century, fifty years ago, the engineer worked largely from handbooks and tables, and the theoretical scientist was engaged in finding out how the engineer was able to do what he did. A quick eye for the factor of safety made all the difference between the good and the poor practitioner. In such times it was necessary to know all the tricks of the trade. It was necessary to have in mind all the previous ways in which the problem had been solved, for these solutions had been made by chance, and not in the cool, gray light of scientific analysis or deduction.

Today, the factor of safety has been largely replaced by experimental stress analysis, the theory of statistics, and higher mathematics, but our engineering training is still designed largely along craft lines.

To spare embarrassment among my listeners, I will not bear down on the horrible examples where the students' time is taken by memorizing catalog types rather than by memorizing basic principles. This would be less serious if a young man could forecast his employment accurately and remain with it for the rest of his life. Some few do, but the vast majority will work in five or ten different industries, or at least, different companies. It is a rare individual who spends all of his life in the industry of his first job, or even in the course and option in which he graduated!

It has been my further observation that the types of activity engaged in by engineering graduates do not correspond with the customary, civil, mechanical, electrical, and chemical divisions, but rather with a division roughly into sales, research, design, production, and operation. These latter divisions involve human personalities and aptitudes; the former ones assume the learning of specific names and numbers.

Let me recite an example. I once worked with an industry which proudly boasted that it had no experimental department as such. It had an engineering department, and the engineering department handled all work involving design changes or innovations. The result was utter mediocrity at all levels. A call for a new product would stir reminiscences that shop tooling must be maintained without changes, while the making of a minor change to facilitate production would be delayed while the engineer attempted to work in all the little improvements that he had in mind and had been waiting to drop into the production model. As I have said, the end result was mediocrity, confusion, and frustration. How much more could have been accomplished had the research and de-

* Presented at the Annual Southwest Section Meeting of ASEE, University of Texas, April, 1954.

velopment problems been separated from the production problems, and both from maintenance problems?

Timeless Principles

I hope this little example will bring out that the technical graduate needs a good and thorough grounding in fundamentals of a science, and he does not need to learn in school those practical tricks that are applicable to a particular industry. Time does not permit this luxury. This evil is further enhanced when we recall that it is not possible to keep our textbooks or exhibit collections up to date, nor anywhere near complete. At our best, we must show the student old examples and limited ones. Let us better use our time to show him fundamental, universal, and timeless principles, which he can apply all through his life, regardless of job changes.

This diatribe, while general, is particularly applicable to those students who will go into research. The Armour Research Foundation has stated that, in selecting employees, it searches, not so much for what the man knows, but for what he can learn. The good researcher must exist in a state of educated ignorance and curiosity.

An excellent paper on this subject appeared by W. L. Everitt in the Journal of Engineering Education in December 1951. In it, he developed the following seven objectives of engineering training, which I feel should be called to your attention at this time. They are:

1. Knowledge and appreciation of history
2. Formulation of problems
3. Collection of information
4. Distinguishing the revelant from the irrelevant
5. Non-quantitative evaluation—particularly a companion of numerical analysis
6. Translation of analysis into conclusions which are then reduced to specific recommendations
7. Oral and written presentations in a form designed to accomplish a clearly perceived, practical purpose.

Reduced to absolute fundamentals, Everitt said it was the purpose of engineering education to:

1. Teach Fundamentals
2. Teach to Think
3. Teach to Achieve Action

Note that no limitation of field of application is placed here.

Time places many limitations on what we would like to impart to our successors. Time is limited by their urge and desire to enter life and also to secure economic independence. As educators, it is our duty to impart to them that which they cannot secure outside of the university, and that is fundamentals—fundamental knowledge, in as detailed and as thorough a manner as possible. Remember, applications and interests will change and can be learned on the job, but only in the university do the economic conditions and the proper atmosphere exist for thorough, continued, and repeated drill in basic scientific and engineering fundamentals!

The average graduated research worker is not an outstanding genius. He is usually a slow, and thorough man. He is a man who has enough education and training to recognize his problem and to develop its leads, but he is not so learned that he rejects the help of others. The day of the ivory tower is past. I can tell you again of watching one of my associates, a biologist, develop into a research team. His first assistant was a photographer, to record the specimens; then came a physiologist, to deduce the reactions in question; a pharmacist, to prepare the necessary chemicals, and a statistician, to plan, to refine, and to analyze the experiments for artifacts and random influences and levels of significance. Today's researcher must ask questions, not only of himself and his books, but also of others. He must be a sociable person, for he works in fields which have not been tilled before, and he needs help

in removing the rocks and digging out the stumps which must be done before straight furrows may be plowed.

Virtues of Collaboration

I cannot emphasize too much that the research worker must be ignorant, he must be inquiring, he must never decide that he has all the answers and that others cannot be helpful. The fields of knowledge today are too deep and too complex for one man to navigate alone. Further, we must give some credit to our ancestors. They were not entirely knuckleheads, and they have solved all the easy problems by now. Today, we must progress through teamwork. Therefore, teach your young men the virtues of collaboration.

I have earlier stressed the necessity of thorough training in fundamentals. The research worker needs to know the existance of all fields. He needs to know when to call in a stress analyst, a microwave specialist, a surface chemist, a statistician, a photographer, a writer, a lawyer, or other consultant. I agree that there is a limit to what can be covered in college, but we must spend some time in telling of the other fields in order that the new worker may realize his limitations and also realize that these limitations can be broken by help from the right people. Within these many fields, he must find one specialty, and he must work that specialty to death. He must know its history, the story of its early pitfalls and false hypotheses, of caloric and of phlogiston. In this field, he should know the alternate methods, the short cuts, and the present applications. Here, alone, I will relax my strict rule against memorizing the hardware of the art. In the prime specialty, knowledge of the hardware is essential, but it should be gained in practical work and not at the earlier expense of theory. Our good researcher will now also learn what is not there. He will see the missing links and know the uncharted areas and he may even find out why those areas have been avoided by the earlier workers. Perhaps they have just been overlooked, or perhaps they are the real "stinkers." Many a man has been caught in a research project because he did not realize that the project he undertook had remained unsolved because of some minute, but inherent difficulty. In short, develop your research man to browse and to dream a little, or as Bacon said, "to weigh and consider."

Perhaps by now, I have spoken too much—I have spoken in parables and confusion. I have advised specialization, without losing sight of collateral objectives. I advise theory, and practical applications; I advise deep learning, and a curious ignorance. I plead for the man who has the courage and the confidence to go it alone, and I advise him to consult with others always. But above all, I counsel a thorough knowledge of scientific fundamentals and a fierce desire never to age, but to keep young through the curious investigation and acquisition of new knowledge throughout life.

Mid-Winter Meeting of Engineering Drawing Division

Time: January 27, 28, 29, 1955

Place: University of Tennessee, Knoxville, Tenn.

A three day session of technical programs and inspection trips which will include technical papers and panel discussions by teachers of engineering drawing and men from industry. Inspection trips will include the Oak Ridge National Laboratories and Great Smoky Mountain National Park. Detailed programs will be mailed to members of the Engineering Drawing Division.

Basic Science and Design in Soil Mechanics*

By HOWARD P. HALL

Associate Professor of Civil Engineering, Northwestern University

Statement of the Problem

The occasion for this paper is a panel discussion whose theme is the effect of the recommendations of the Engineering Evaluation Committee on courses in soil mechanics and transportation, with particular reference to the relation that those subjects may bear to a broad engineering curriculum of the kind identified in the Committee Report as professional-scientific. I have chosen to treat the subject at hand by suggesting some fundamental strategy that could be applied to an entire curriculum, and showing how such an approach would work out in the case of undergraduate instruction in soil mechanics.

The situation that requires attention, familiar enough to need no detailed description, is the lack of sufficient time in a normal four-year curriculum to treat all the subject matter that most of us consider important, to the extent that we consider adequate, and within the framework of the present conventional breakdown of subjects.

I do not consider lengthening the curriculum to be a satisfactory solution. In my opinion, to go to a five-year curriculum now would only hasten the day when agitation would begin to make it six; and so on without end. The fallacy in this approach, I think, is the implication that something is being completed in this period, and that it now takes longer to complete it than it used to. I think we find that any end we think we see in this case is a mirage: We may move toward it, but it doesn't seem to get any closer, and we finally succumb to disappointment, frustration—and an even longer curriculum.

Briefly, then, while I do not suggest that there is any magic in the number four, I think that four years is enough time for a capable young man to spend as an unproductive learner at whatever his chosen calling may be. Thus, the real challenge to us is to build an adequate foundation in the four years that we now have.

Analysis

The objective of a program of education in engineering is of course to develop the qualifications that a competent engineer should have. From a technical standpoint, facility in design appears to be among the foremost of these qualifications, and to be as well the function that distinguishes an engineer more sharply than any other single feature from other practitioners in science. The term design is used here in what I understand to be its accepted sense, that is, the origination of a machine, structure, or system. A design need not be the first of its kind, although it frequently is in part. It need not serve a useful purpose, but exceptions of this kind are trivial. And of course, it need not even work, since that consideration only introduces the quality of the design. Essentially, it is necessary only that the specific machine or structure or system not have been available before.

There is one important restriction that should perhaps be made in considering

* Presented at the Annual Meeting, ASEE, Civil Engineering Section, University of Illinois, June, 1954.

design as a distinguishing function of an engineer, and that is that it is understood to be directed down scientific channels. An architect, by contrast, is a designer; but to the extent that his design is concerned with aesthetic considerations, his work is not engineering.[1] This introduces what I take to be the second major qualification of an engineer, namely a background of basic science. However, to imply, as I have, that a background of basic science is prerequisite to competent design is to invite protests from those who have known excellent designers who had had no formal education and who appeared to have no organized understanding of basic science. My conception of the appropriate answer to these protests follows.

Theory and Experience

It would be well to note parenthetically at this point that in advocating a thorough grounding in basic science I am in effect expressing a preference for what has been labelled professional-scientific as distinct from professional-general, and am applying that preference to any curriculum that is to be specifically identified as some kind of engineering.

To return to the question of the importance of a background of basic science to design and therefore to engineering, we may note at the outset that competent design pre-supposes a combination of some degree of knowledge of how the materials and other elements in question will behave and sufficient judgment to recognize and make suitable allowance for the gaps in that knowledge. This vital factor of judgment comes primarily from experience, but it seems to me that even the widest experience can contribute effectively to the development of judgment only through the evaluation of that experience against the theoretical scientific background from which it constitutes a continuous deviation. Many able engineers have discarded theory to varying degrees; but none, I think, has got away with it without first having mastered the theory that he has discarded. Consequently, it may be argued with justification that he hasn't discarded theory at all, but has softened its rigor with so many modifications that its analytical tools lose their efficiency. Perhaps the real point I am making here is to stress the distinction between a misleading theory of rigorous formulas and a reliable but computationally unwieldy theory that consists of a fundamental understanding of the laws of nature. The latter, in my opinion, can never be discarded because the natural laws that make it up govern the behavior of everything on earth whether we like it or not. Our job is to untangle the threads, and those who swear by theory, as well as those who swear at it, are actually all carrying on the search for basic science in the most promising way they know.

A Proposed Solution

If we accept the premise that basic science and design should constitute the vital elements of an engineering curriculum, it follows that attention to these elements should be continuous in a curriculum, that is, that the presentation of each course should be such as to make its background in basic science clear and such as to indicate its design potentialities.

The undergraduate who has the clearest view of basic science is, I think, the one who sees it as composed of the fewest unrelated parts. The greater the number of elements that can be arranged in a patently logical sequence, the smaller the number that is left as a list to be memorized. Thus, it becomes the task of the instructor to call attention continually to the fact that the mathematics, physics, and chemistry in, let us say, soil mechanics are the same in their essence as they were when they appeared in structures, thermodynamics, or under their

[1] This is not to say that an engineer need not concern himself with aesthetic considerations.

own names. The result of such an approach is admittedly to reach no new areas of application directly; but it appears to me to have the advantage of developing greater resilience in the student's response to the unfamiliar, and therefore greater potential ability to apply principles to the unforeseeable variety of problems that cannot possibly be treated in a college curriculum.

In the case of the design element in engineering instruction, the approach that I am proposing is again one that does not add to the graduating student's collection of specifics. Here the important thing is to call attention, not simply to the fact that an observed phenomenon differs from the theoretical version, but to the areas of theory that are found wanting, to the ways in which the discrepancies appear to refute theory, to the most likely reasons why such differences occur, and to what can be done about it. Thus the student emerges, not with the impression of an irreconcilable conflict between theory and experience, but with an intelligent awareness of the shortcomings of current theory, and some idea of the directions in which he must look for information that will lead to a better understanding of the laws of nature if his own experience is ever to become something more than a mass of untutored observations that are related obscurely if at all.

Instruction in Soil Mechanics as an Illustration

I have selected soil mechanics as the subject with which to illustrate the application of the foregoing ideas partly because it is the one that I am most familiar with and, perhaps a little more urgently, because it is one of the subjects mentioned in the title of this panel. By a lucky coincidence, it also illustrates my argument very well.

Early in a course in soil mechanics the subject of clay soils, clay minerals, and some of the attempts to account for their properties and behavior may come up. It will frequently not occur to the average student at this point in a soil mechanics course that the instructor is duplicating or building directly upon something he learned in freshman chemistry or sophomore physics. If the identity can be clearly established, the student can be persuaded to accept this part of the course as essentially the retracing of steps already taken, rather than as the first faltering step into the darkness of a strange land. Thus, he realizes that the material under discussion lies at least partly in a familiar area and is not really new in the severest sense. The resulting psychological gain can sometimes be converted into the saving of some instructional time.

Mohr's Circle is identified by many undergraduates as a peculiarly frustrating part of the science of soil mechanics. Considerable advantage can be gained if the time is taken to show that Mohr's construction is simply a pictorial way of writing the equations of statics and has nothing to do with soil mechanics. Even greater advantage can of course be gained by having introduced Mohr's Circle in elementary mechanics, so that a distinct point can be made of the tie-in at the time of its introduction into the soil mechanics course.

One of the most fruitful areas for calling attention to common scientific principles is the field of flow. In soil mechanics, it is convenient to begin a discussion of seepage with Darcy's law; and more advanced treatment frequently proceeds to Laplace's equation. Yet the only appreciable prior contact the average student in a soil mechanics course has had with the flow of water has been in fluid mechanics or hydraulics courses, where Bernoulli's equation was the central theme. It will not occur to the average student to attempt to reconcile these expressions; but if their consistency with common principles is established, the misconception of a whole new science of flow, peculiar to soils, or at least to por-

ous media, is corrected, and the existence of the extent of common base understood. This revelation will sometimes encourage a student to trace this particular common element much farther afield, and in any case will leave him better prepared to cope with unusual problems that cannot be treated adequately as part of his formal education.

The shrinkage of a clay provides the soil mechanics instructor with a chance to develop in the student some measure of understanding of surface tension and capillary action—subjects of increasing importance that ordinarily get little attention in a standard curriculum.

Turning to the design element, we find that soil mechanics has a built-in feature that lends itself extraordinarily well to the presentation of this phase of the subject: The majority of natural soils are among the most inhomogeneous of all engineering materials. Not only that but the inhomogeneities are sometimes just regular enough to tempt the bold, if not the wise. As a result, it is of the greatest importance in the design of foundations and earth structures to complement theory with judgment based on experience.

The two major objectives in the design of foundations—safety against excessive settlement and safety against rupture—are ably represented in theoretical mechanics; the one in the form of a well-worked-out mathematical theory of consolidation, the other in several straightforward techniques of stress analysis. The theories are reliable if the soil is homogeneous and if the designer can evaluate the appropriate constants. To the extent that these two if's remain contrary to fact, judgment is the designer's only recourse. And the instructor who gives the impression of turning his back upon theory in such a case not only, in my opinion, misleads the student, but also misses one of the best opportunities in an engineering curriculum to trace the interaction of theory and judgment in the mind of a competent engineer. For theory is still there to give the designer at least an inkling as to what elements are important, which of them are paramount, and how each affects the answer. In fact, it cannot be other than theory, although of an informal kind, that tells even the designer-by-precedent which of the cases in his experience is the truest precedent.

Conclusion

If the argument presented in the foregoing paragraphs has any validity, it applies to any technical subject in an engineering curriculum. I have used soil mechanics to illustrate the argument, not the argument to defend the place of soil mechanics in a curriculum.

The result of the approach suggested will not necessarily be the clearing of space in a curriculum for more engineering applications—possibly even to the contrary. The result that I consider possible and desirable is the development of sufficient potential in an undergraduate to make him capable, if the occasion arises, of handling many more problems of a non-routine kind than space could ever be cleared for in a curriculum of acceptable length.

To introduce a familiar parallel in the economic field, I am suggesting that if we concentrate, in engineering curricula, on what could be called capital knowledge, which can serve a number of objectives, we shall come closer to covering the field than if we keep adding consumers' knowledge, each of whose items ordinarily serves but one purpose.

A final point in favor of the suggested approach is the consideration that efficiency is secured by making the subject matter of any course serve at least two purposes—namely, the immediate one of providing specific instruction in a particular subject, and the more far-reaching one of developing one or both of the two general requirements of a competent engineer. Furthermore, the inclusion of this material in every course removes, at least to some extent, the urgency of devoting whole courses solely to design.

A Realistic Approach to Reinforced Concrete*

Ultimate Strength Theory in a Senior Course

By PHIL M. FERGUSON

Professor of Civil Engineering, The University of Texas

Fundamentals Come First

A course must be built upon a philosophy of engineering education just as surely as must a curriculum. If it is a senior course, the appropriate philosophy may be quite similar to that governing the curriculum as a whole.

Present day curricula are gradually moving in the direction of more theory and less practice. They reflect sweeping changes in many areas, in civil engineering, for example, from hydraulics to fluid mechanics, from foundations to soil mechanics. They reflect totally new methods such as photogrammetry and radioisotopes. Incidentally, this increasing complexity of the civil engineering field raises serious problems which can scarcely be mentioned here, such as the increased need for graduate study, and the increased need for apprenticeship training which is only partially available.

Reinforced concrete is also moving in the direction of a better understanding of fundamentals. But one distinction must be made here. This is not a movement in the direction of a more mathematical treatment of the subject. Rather it is a movement in the direction of a better understanding of the physical action of reinforced concrete. Unfortunately our knowledge of the physical properties of concrete is not adequate now to support a mathematical analysis that can be projected with confidence into untested areas. This means that the better understanding of fundamentals is actually arising, and can only arise, from increased laboratory and field investigation and research.

At the same time reinforced concrete practice is, as usual, far in advance of our theory. Prestressed concrete is seeing increased usage. Thin shell barrel arch roofs and domes and spectacular folded plane or hip plate structures are becoming more common.

Thus there is pressure on a senior course in reinforced concrete from both sides—fundamental understanding and advanced applications. Under these conditions the teacher should not hesitate to leave advanced applications for graduate study and concentrate on a better student grasp of the way reinforced concrete really acts. Such an objective is not inconsistent with the necessity of informing the student of present-day specifications and present-day procedures. A school must be realistic enough to understand that its students go out into a very practical and highly competitive world that operates on the basis of present day specifications. The student should understand the basis for these specifications insofar as possible. But it is even more important that he understand some of the weak points in these specifications and have his mind opened to changes that seem to be in the making.

Ultimate Strength Theory Is Fundamental

What are some of these changes? The most probable early change seems

* Presented at the Southwest Section, ASEE, before the Architectural Engineering and Civil Engineering Divisions, April 17, 1954.

to be the adoption of ultimate strength theory for bending and for combined direct stress and bending. Ultimate strength theory is already in our column specifications, although it is somewhat disguised. Changes in our specifications for shear or diagonal tension are not many years away. And splitting, as a limitation upon bond strength, is certain to require specification changes soon.

All of these are here lumped together as various aspects of an ultimate strength theory, although this term has commonly been considered chiefly in its relation to bending or direct loading or combinations of these. A distinction must be made here between ultimate strength methods and limit design. Ultimate strength is used here to refer to the maximum strength of a given cross-section. This strength exists regardless of the size of the moment or shear or axial load destined to act on the member. It is entirely distinct from those ideas of limit design relating primarily to the favorable readjustment of moments in continuous beams or frames under overload conditions. Ultimate strength theory applies to statically determinate members as well as to indeterminate structures.

Ultimate strength theory implies that working stresses will be neglected in favor of ultimate strengths, and that working loads, moments, and shears will be increased by a load factor or load factors for design purposes. The straight line stress theory has no place in this procedure because the straight line stress distribution does not exist at ultimate strength loads.

The Senior Course Can Include Ultimate Strength

Can two such contradictory approaches as ultimate strength and straight line stress distribution be included in a single beginning course without seriously expanding it? The answer is affirmative, because we do not need to make students into experts in the area of ultimate strength. The ground rules for such design are still being formulated and may be different tomorrow. What the student needs is basic understanding, no more. At the University of Texas we have found it easy to give this general understanding, at very little cost in time.

Since 1950, the study of reinforced concrete has started, at the very beginning of the course, with ultimate strengths —how beams fail in moment. A slight change is being made this year: axially loaded column discussion is being moved ahead of beams. As thus projected, the ultimate strength elements proceed in the following fashion.

The course starts with a brief discussion of the relative strength of plain concrete in compression and tension and the need for reinforcing steel in beams and columns.

Column Tests First

Columns (without bending) are to be introduced immediately, with about one period devoted to a discussion of the extensive column tests of the early thirties. This involves recognition of inelastic factors such as shrinkage and creep (or flow) of concrete right at the start. It is pointed out that although one cannot, with any respectable accuracy, calculate actual column stresses under axial load, he can determine ultimate column capacity rather closely. The column has the combined ultimate strengths of the concrete and the steel considered separately. This is presented as a true ultimate strength theory, slightly modified in form in the specifications. The basis of the present A.C.I. column formula is explained; the negligible difference in action between a spiral and a tied column up to the yield point is emphasized, and the different factors of safety used for concrete and steel, for tied and spiral columns, are pointed out. The spiral steel requirement is related to test data. Problems with the standard A.C.I. column formula are assigned at this stage.

Beam Action and Beam Ultimate Strength

Beam theory is next introduced, again by a study of ultimate strength—how beams fail. The resisting couple in the reinforced concrete beam is discussed, with C represented as a resultant force not yet located. The moment $M = C.jd = T.jd$ is developed with standard definitions for j and d. Thus far, this could just as well be the approach for a discussion of the straight-line theory. But here the presentation changes.

The complete stress-strain curve for concrete in compression is presented next, with particular emphasis on that portion beyond the peak or maximum stress. The student is reminded that his experience in testing cylinders fits this picture—the balance beam on the mechanical testing machine (or the dial reading on the hydraulic machine) always drops well ahead of failure. The student, at the start of this discussion, is given nine pages of notes in order to permit him to give undivided attention to the lecture presentation rather than to taking notes. Unfortunately, no printed text is yet available for this treatment of the subject.

Next, the probable distribution of compressive stresses in the beam under increasing load is discussed: at small loads, triangular or straight line; at moderate or working loads, slightly curved; near ultimate load, parabolic; and at ultimate load, with extreme fiber stress less than the maximum stess, i.e., as presented by Whitney. All of this is specified to be at first loading without prior shrinkage. Reference is then made to the standard working stress (straight line) theory and some of its weaknesses, as follows:

"Although present day specifications emphasize stresses at working loads and present day calculations pretend to calculate these stresses, laboratory tests of reinforced concrete beams show that actual deformations and stresses at working loads only faintly resemble our calculated values. In other words, present day specifications and the corresponding standard calculation procedures are not representative of the real action of reinforced concrete beams under working loads. Neither are they representative of ultimate load conditions. They are totally artificial and have been applied with allowable unit stresses empirically adjusted to give safe results."

It is then suggested that ultimate strengths are not only easier to determine but also more realistic. The failure patterns are next developed, at first definitely excluding the progressive cracking on the tension side and considering this area as though initially cracked.

A tension failure is associated with a rising neutral axis as the steel passes its yield point. The rising axis reduces the compression area until a secondary compression failure follows. Deflection is greatly increased near failure. No mathematical analysis of any of this is attempted at this stage.

A compression failure develops with a lowering of the neutral axis and a significant increase in the area under compression. Failure is sudden, without much prior warning.

A balanced beam (at failure) is defined, and the small effect of greater tension steel than this amount is noted. The small effect of shrinkage and creep upon ultimate strength is also pointed out.

At this point the student has a good picture in mind of concrete beam action and is ready for algebraic treatment. Whitney's ultimate strength relations are then presented very simply:

1. The stress block as a substitute conception for C.
2. $M_{ult} = (1/3) f'_c b d^2$ as an impirical relationship for a compression failure.
3. Tension failure measured by the secondary compressive failure, for which the final stress block is just deep enough to give $C = A_s f_y$.
4. The maximum stress block, empirically determined by Whitney as 0.537 d in depth, which defines a

balanced section. Further steel adds little (nothing at all according to Whitney).

A few very brief problems are assigned to illustrate Whitney's method.

A parabolic stress distribution problem for a compression failure is given next, as an example of related procedures in use 50 years ago. No attempt is made at this stage to discuss double-reinforced beams, T-beams, or combined direct stress and bending. The load factor, to get desired ultimate moment from working loads, is briefly mentioned. A total of four or five periods is required for all this beam treatment.

Working Stress Methods Related to Tests

The course then reverts to standard working stress methods. The ultimate strength theory is, however, often used for comparison or reference. For instance, the allowable moment by the allowable stress theory (on an overreinforced beam) is compared to the Whitney ultimate moment value. This gives the opportunity for a definition of factor of safety in terms of load factor instead of the ratio of ultimate stress to working stress.

When beam compression steel is introduced in the course, the effect of shrinkage and concrete creep (or flow) on columns is briefly reviewed, noting that high steel stresses, much in excess of nf_c, were revealed by these tests. This discussion makes a compression steel stress limitation of $2nf_c$ seem rather reasonable.

The present treatment of combined direct stress and bending presents a philosophical problem. The calculation of "stresses" here when we know we cannot do this even for the simple axial load is awkward, to say the least. This material is presented as the necessary patch-work between an ultimate strength theory for columns and a working stress theory for beams. Fortunately there appears to be a good chance that the next A.C.I. Code, in 1955, will improve this situation by adopting a relation similar to the one used now in steel design: $f_a/F_a + f_b/F_b = 1$.

Other areas also need to be introduced from an experimental viewpoint. The subject of footings can be initiated with a brief review of Richart's 1948 tests. Although diagonal tension design has had very little recent data to support it, extensive tests at the University of Illinois will shortly be reported that will call for a complete realignment of ideas in this area. Recent tests at the University of Texas indicate that some new factors must be considered in the field of bond stress. Although not all of these factors are included in the usual concept of ultimate strength theory, they all measure ultimate strength in some form and seem properly a part of the overall theory.

Summary: The Elementary Strength of Materials Approach Is Inadequate

The main thesis of this paper is derived from the considered opinion that reinforced concrete design theory should not be treated as a simple adaptation of the junior strength of materials course. Where it has been so treated, unrealistic relationships have resulted that ultimately have to be discarded or modified. Reinforced concrete is in fact so complex in action that its behavior can be predicted with satisfactory accuracy only on the basis of laboratory investigations. Investigation at times leads to results agreeing with elementary theory; but just as frequently it does not.

It follows that our emphasis in senior courses should be on this empirical or experimental approach. When we neglect this approach our students go out with a false sense of security. They are not prepared to accept promptly the inevitable changes in concrete design that lie ahead. The slow acceptance of ultimate design theory to date and the antagonistic reaction it first receives from many engi-

neers are evidence that the engineering schools have *not* done a good job in preparing students for change.

Present concrete theory is certainly not infallible. It certainly ought not to be taught as though it were. Unfortunately, textbooks are not yet ready to lead the profession in this fashion. The teacher must work out his own supplementary material. Nevertheless, the basic reinforced concrete course can be a most satisfying effort to any teacher who really accepts this challenge for a realistic empirical approach.

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The following rules were adopted by the General Council of the ASEE:

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The Professional Union—A Contradiction*

By CLARENCE T. SHOCH

Vice President, Northeastern Region, National Society of Professional Engineers

Let us permit our imaginations to run freely just a moment and picture ourselves sitting in at a convention held in Los Angeles in February, 1953, with men who call themselves engineers, and hearing the speaker utter the following words:

> We must . . . expose those employer-dominated groups who purport to speak for engineers and scientists, but who in reality speak for management. These groups, such as NSPE, are controlled entirely by management people who are so far removed from the engineering employee that they cannot possibly know his problems, his desires or his needs.
>
> . . . collective bargaining . . . is by far the most direct and the most potent device . . . we have to assist us in obtaining our goal.
>
> Economic weapons such as strikes shall be resorted to . . . when . . . other avenues toward settlement of the differences have been . . . explored and found unworkable.
>
> We must establish closer relationships with the science and engineering students in our colleges and universities.
>
> We must make our various publications available to them;
>
> We must encourage our members and leaders to write articles for their department or college organs.
>
> We must inform . . . students that
>
> (a) Employers are hoarding engineers and scientists
>
> (b) The engineering shortage is largely synthetic
>
> (c) Glamorizing engineering as a profession to attract more students to engineering courses should be stopped.

Those words were spoken by one whose organization has the stated objective, incongruous though it may be in part—"To promote the economic, *professional* (emphasis added) and social welfare of engineering and scientific employees." The speaker was, of course, the President of the Engineers and Scientists of America, on the occasion of the first convention of that group. The philosophy expressed is that of collective bargaining. The words have a sinister sound to us, and portend a situation in engineering circles totally foreign to the generally accepted philosophy of a professional man.

It must be definitely understood that what we are about to discuss is not to be an indictment of unions. Neither will it be a blanket endorsement of management. The pattern of economic relationships existing in our system of devising and producing this world's goods is far too complex to permit any broad conclusion that the labor practices of either unions or managements have been either (a) the salvation of this country's economic leadership, or (b) its greatest obstacle.

Our immediate problem really has little to do with employers or employees as such, although we will unavoidably explore areas where better understanding between those groups would facilitate a decision we must make for ourselves as members of the engineering profession—that of whether to hold to the principles of professionalism or accept the collective bargaining concept. We can't do both. Somewhere along the line we must take a stand in support of our consciences.

*Presented at the Allegheny Section Meeting of ASEE, April 30, 1954.

ESA as a Symbol

Taken more or less as a symbol of the problem we face, let us review the progress that has been made in the aforementioned new organization of engineers—that of the Engineers and Scientists of America, a nation-wide federation of bargaining units. The units comprising this federation are, otherwise, "independent" unions, established in plants and at locations as follows:

The net representation of this group is approximately 21,000. ESA claims to have applications from other groups with representation totalling 15,000. The grand total accounts, roughly, for their claim of 40,000 representation. Remember though, the actual membership in these unions may be substantially less, for under the law a union needs only a simple majority of those eligible to vote for representation to be in a position to claim representation for the entire group.

Union Name (1)	*Company* (1)	*Claimed* (2) *Representation*
Assn. of Engrs. and Engin. Assistants	G. E. Switchgear Works, Phila., Pa.	240 (3)
	Shell Development, Emeryville, Cal.	400
Assn. of Industrial Scientists	R.C.A., Camden, N. J.	810
Assn. of Professional Engin. Personnel	W.E. Co. (Nation-wide)	5,000
Council of Western Electric Tech. Employees		
Engineers and Architects Assn.	Lockheed Aircraft, L. A.; Lockheed-Aircraft Service; Consolidated-Vultee Aircraft, San Diego; Rheem Manufacturing, L. A.; City and County of Los Angeles	4,800 (4)
Engineers Association	Sperry Gyroscope, Great Neck, N. Y.	1,900
Engineers Association of ARMA	Arma Corp., Garden City, N. Y.	740
Engineers Guild of Oregon	Timber Structures, Portland; Engineers of the State of Oregon	300
Minneapolis Federation of Honeywell Engrs.	Minneapolis Honeywell Regulator, Minneapolis, Minn.	1,040
San Francisco Area Group of Prof. Engrs.	Pacific Gas & Electric Western Assn. of Engrs., Architects and Surveyors, City of Alameda; East Bay Municipal Utility District	450
Seattle Prof. Engin. Employees Assn.	Boeing Airplane, Seattle, Wash.; Continental Can, Seattle, Wash.	3,500
Southern Calif. Prof. Engin. Assn.	Douglas Aircraft, San Diego; Southern Calif. Gas, L. A.	3,000 (3)
TVA Engineers Assn.	Engrs. of the Tennessee Valley Authority, Southeastern U. S.	2,000
(5) Federation of Arsenal Engineers	Twin City Arsenal Plant of Federal Cartridge Corp., St. Paul	125
	Total	24,305
	Less recent withdrawals	3,900
	Net	20,405

(1) According to recent Congressional testimony.
(2) According to CWETE "Council Compass" for January, 1953.
(3) Recent information indicates that these unions are not current members of ESA.
(4) Recent information indicates that decertification of the Lockheed, Marietta, Ga., unit (1/15/54) has reduced this number approximately 660.
(5) This unit not in original testimony, and is according to the November–December, 1953, issue of *ESA News Digest*.

The Problem Is Not Just Another Engineering Group

Our concern is not that another engineering-type organization has come into being, even one of claimed representation of some 40,000 engineers. We are apprehensive, however, of the stated aims and objectives of this organization, which are at extreme variance with the more altruistic motives expressed by the long established professional engineering societies and associations.

Further, we are concerned with their expressed intent of going into engineering schools and promoting their doctrines to the embryo engineers who will wind up on the management side of the bargaining table in a great majority of cases. To have these young people indoctrinated with purely mercenary motives cannot help but seriously retard, and possibly permanently injure, their chances to achieve maximum success and satisfaction in their chosen careers.

How has the engineering profession been maneuvered into this peculiarly contradictory situation of professing on the one hand to devote its combined talents to the benefit of mankind, and on the other, to foster activities which are extremely controversial as to their public interest value?

Representative Carroll D. Kearns, speaking before the House Committee on Education and Labor in May, 1953, remarked that "With the passage of the Wagner Act in 1935 it became the policy of the United States Government to foster and promote the concept of collective bargaining as the most satisfactory method of resolving differences and disputes between labor and management." Let's review some of this labor legislation history, particularly as it applies to engineers and their inclusion in the labor category.

Engineers as "Labor"

Representative Kearns' reference to the passage of the Wagner Act in 1935 takes us back to a period when engineers, and practically everyone else in the country, were living through an era of "made work." Under the Government's philosophy of fostering labor's interests, employed engineers were considered to be the same kind of commodity as any other trade or type of employment, and as such were similarly subject to the provisions of the Wagner Act.

But the engineers were "babes in the woods" at the game of organizing for labor advantage. Their numbers among the labor masses, of which they were by law a part, were so insignificant as to make it practically impossible for them to express their wishes, let alone hope that their desires might be given consideration. Most of the time, the objectives and philosophy of the great numbers of the laboring classes were completely out of tune with the philosophy that had been developed by these engineers as a result of their college training and their association with older engineers having the true professional concept.

Despite a lack of common interest between professional engineers and the crafts in the same labor union, it was almost impossible for the professional employees to withdraw. They had to retain membership to hold their jobs and, in many instances, were forced to take part in strikes under the thinly veiled threats commonly used by unprincipled labor groups. No provision in the law would permit engineers and similar professional-type personnel to be classed as professionals, or apart from the usual crafts.

Introduction of the "Professional Provisions" of Taft-Hartley

Events led to a change, however, and in 1946 it became apparent that the Wagner Act would give way to more enlightened over-all considerations.

At that time a determined drive was made by a combined grouping of professional engineer societies consisting of the National Society of Professional En-

gineers, the Engineers Joint Council and the American Society for Engineering Education. This group appeared before committees of Congress and eventually introduced into the new labor law of the land, the so-called "Professional Employee" Provisions. This law, still the ruling document in labor matters, is known as the "Labor Management Relations Act, 1947," or more commonly as the "Taft-Hartley" law.

The so-called professional provisions of Taft-Hartley have been supported vigorously during all meetings of the Congress since 1947. Our group and the professional engineer allies previously mentioned, rallied in 1949 in vigorous support of retaining the professional provisions. These provisions were subjected at that time to the determined efforts of the heterogeneous type unions which, of course, did not want that potential membership to slip away from them.

Again in 1951 there was concerted Taft-Hartley activity by the professional groups. This past Spring, both the National Society and the Engineers Joint Council appeared before committees of both houses of Congress in support of the professional provisions. At that time, the National Society also proposed a further amendment, popularly known as the "Freedom of Association" Bill, H.R. 5504, introduced by Representative Kearns. As you know, the whole subject of Taft-Hartley is presently a matter of national controversy and nothing has been done recently about revising that law.

At this point it would be helpful to review the actual passages in Taft-Hartley which bear upon the development of professional unions among engineers. In an attempt to avoid confusion, some of these passages have been briefed to omit words or phrases not particularly pertinent.

What Is a Collective Bargaining Unit?

Sec. 9 (b)—"The Board shall decide . . . the unit appropriate for the purposes of collective bargaining. . . . Provided, that the Board shall not . . . decide that any unit is appropriate for such purposes if such unit includes both *professional employees* and employees who are not *professional employees* unless a majority of such *professional employees* vote for inclusion in such unit; . . ." (emphasis added).

Note that the foregoing mentioned "professional employees."

Who Is a Professional Employee?

Sec. 2 (12)—"The term 'professional employee' means—

(a) Any employee engaged in work
  (i) Predominantly intellectual and varied in character as opposed to routine mental, manual, mechanical or physical work;
  (ii) Involving the consistent exercise of discretion and judgment in its performance;
  (iii) Of such a character that the output produced or the result accomplished cannot be standardized in relation to a given period of time;
  (iv) Requiring knowledge of an advanced type in a field of science or learning customarily acquired by a prolonged course of specialized intellectual instruction and study in an institution of higher learning or a hospital, as distinguished from a general academic education or from an apprenticeship or from training in the performance of routine mental, manual, or physical processes; or

(b) Any employee, who
  (i) Has completed the courses of specialized intellectual instruction and study described in clause (iv) of paragraph (a), and

(ii) Is performing related work under the supervision of a professional person to qualify himself to become a professional employee as defined in paragraph (a).

These are the parts of the law commonly spoken of as the professional provisions of Taft-Hartley.

Supervisors Are "Out"

At this point it would be well to remember that "supervisors" are specifically barred from participating in collective bargaining. The provision of the law governing this states:

Sec. 14 (a)—". . . no employer . . . shall . . . deem . . . supervisors as employees for . . . collective bargaining."

This provision has a bearing on some of our later considerations.

Freedom of Association Amendment

Following are important quotations from the law in that they establish the basis for NSPE's proposed Freedom of Association amendment. The first pertains to a definition of a labor organization.

What Is a Labor Organization?

Sec. 2 (5)—"The term 'labor organization' means any organization of any kind, or any agency or employee representation committee or plan, in which employees participate and which exists for the purpose, in whole or in part, of dealing with employers concerning grievances, labor disputes, wages, rates of pay, hours of employment, or *conditions of work*" (emphasis added).

In the above it is very important that we keep in mind the words "conditions of work." These words used commonly in terms of employment might be expected to mean simply the adequacy of shop or office equipment, proper toilet and wash room facilities, elevator service where necessary, clean, well-ventilated working spaces, lunch and locker rooms, etc. However when dealing with a law which has been established primarily *for the aggressive protection of the working man,* it is entirely possible that the words "conditions of work" would also be interpreted to include the activities of groups of employees growing out of their efforts to devote themselves to professional development and professional recognition, and where working conditions were only collateral considerations. This might come about, for example, if the plan for the professional development of engineers in a plant included the scheduling of their employment in various jobs on a rotation basis, or encouraged them to use their own free time in the laboratory or shop in the interest of self-development.

In some instances, professional engineers have formed local associations within a plant which are not, and are not intended to be, collective bargaining agencies, but rather are designed to provide a vehicle whereby all professional engineer members may consider their mutual problems. These local associations or groups, sometimes referred to as "sounding-board" groups, include within their membership both employee professional engineers and management professional engineers, the reasoning being that all such personnel are members of the same profession, and consequently have mutual professional interests. This is desirable because without such integration at all levels of professional thinking, the profession loses its cohesive nature and the benefit of open interchange of ideas, opinions and comments. A "problem" exists because the management professional engineers are included in the membership of these local associations or groups, for both the group itself and the employing company might be cited for an unfair labor practice under the following provision of the law.

What Is an Unfair Labor Practice?

Sec. 8 (a)—"It shall be an unfair labor practice for an employer—

(1) To interfere with, restrain, or coerce employees in the exercise of rights guaranteed . . . .

(2) To dominate or interfere with the formation or administration of any labor organization or contribute financial or other support to it: . . ."

Because of the integrated nature of local engineer groups and because in their operations they may touch upon working conditions, they are under a constant cloud of being attacked as company-dominated labor organizations in view of the broad legal definition of the term "labor organization." Company domination is considered possible because the management professional engineers in the group might be construed as using their influence and membership participation to sway the general membership away from collective bargaining.

The following quotation from the Seventeenth Annual Report of the National Labor Relations Board bears on this situation:

> The Board customarily finds a labor organization to be employer-dominated where its formation was instigated or encouraged by the employer, where supervisors or other management representatives participated in its formation or have a voice in the administration of its affairs, and where the employer provides financial or other support in the organization.

Permit Professional Men to Make Own Choice

We are of the opinion that professional personnel are intelligent enough to elect between collective bargaining and any other channel of communication with management, and are not likely to be dominated in that choice. Nor do we feel that the public interest is served by a condition of the law which tends to encourage one choice while placing limitations upon the other.

The full and free interchange between all members of the engineering profession has been a vital factor in the industrial development of the nation. In fact, it is the way in which the profession has progressed in its technical advancement for more than a hundred years. The technical organizations of the profession make no artificial distinctions in meetings and publications as between those who are employees and those who are management. The same lack of distinction in matters of professional development and activity is needed for continued industrial progress.

NSPE's Proposed Amendment re: Freedom of Association

Those professional employees who desire to be represented through a union and collective bargaining procedure should be permitted to do so. Those who do not should likewise be protected in their rights. Such a result may be achieved by the simple step of having the law specifically permit the members of a profession, including both employee and management personnel, to form and participate in organizations to consider mutual professional problems if those persons have not affiliated with, or are not represented by, a union. This can be accomplished by having that part of the law defining a labor organization amend as follows (proposed amendment in italics):

> Sec. 2 (5)—"The term 'labor organization' means any organization of any kind, or any agency or employee representation committee or plan, in which employees participate and which exists for the purpose, in whole or in part, of dealing with employers concerning grievances, labor disputes, wages, rates of pay, hours of employment, or conditions of work. *Provided, that the term 'labor organization' shall not include organizations of professional per-*

sonnel as defined in Section 2 (12) of this Act if the Board has not certified or the employer has not recognized a representative as their representative under Section 9."

The above proposed revision of Section 2 (5) is the proposal of Representative Kearns in House Bill 5504, known to us as the "Freedom of Association" Amendment.

Now back to ESA for a moment. ESA has proposed in their testimony before the House Committee that the Taft-Hartley law be revised in several respects. Here are their particular points, amplified by the apparent reason for their suggestions.

ESA's Suggested Taft-Hartley Changes

1. A redefinition of supervisory employees to exclude those not having "true management functions," to make a greater number of professional personnel available for union membership.

2. A prohibition to cause employers to cease dealing with other than legitimate unions on the subject of wages, hours and working conditions. This would outlaw the sounding-board type of engineer groups described previously.

3. Application of Taft-Hartley to employees of public agencies and wholly owned government corporations. This would permit engineer employees of TVA, etc., to carry on all collective bargaining tactics, including strikes.

4. Repeal of the Free Speech Provisions in Taft-Hartley, thereby curbing an employer's right to speak to his employees concerning their organization for bargaining purposes.

5. Repeal of the Decertification Provision. This would eliminate the possibility of engineer employees getting out from under union organization.

6. Elimination of the imposition of respective state laws on union security and check-off, which now prevent these matters on a state-by-state basis.

7. Freedom to bargain without restraint or limitations. They want no restriction placed upon nation-wide or industry-wide collective bargaining.

How Others Contrast the Professional-Union Philosophies

As an interesting sidelight on the proceedings before the House Committee, I offer the following quotation from the transcript of the record to indicate the attitude of one of our eminent legislators on the comparison of the professional philosophy vs. the collective bargaining concept. This bit of repartee took place toward the close of the questioning by the Representatives who had heard NSPE's and EJC's testimony advancing the professional philosophy, followed by the testimony of ESA which had suggested many changes in Taft-Hartley strictly along the lines of the union approach. Chairman McConnell stated to ESA President Amann:

"I must confess that I had not seen the opening part of your statement where you say you are a federation of labor unions. Now I can begin to understand. I was thinking of you as an engineering society. I thought you were taking on all the characteristics of a labor union. I couldn't understand it."

After Mr. Amann had confirmed that the ESA groups were certified collective bargaining labor unions, Chairman McConnell continued:

"These gentlemen," pointing to the NSPE and EJC representatives, "to make sure, are what I understand is an engineering society. I can get the difference in your philosophy and background now when I get that additional understanding. I didn't have it before. I thought this group (ESA) were talking like a labor organization and this group (NSPE and EJC representatives) like a professional society. I thought you were all professional societies and it was confusing to me."

Mr. Amann—"I should like to suggest, Mr. Chairman, that we are as professional as this group, if I may."

Chairman McConnell—"You may be in your background, but in what you advocate here you are taking on very definitely to me, as we understand the jargon, the labor organization viewpoint."

Mr. Amann—"That is right. We are a labor organization."

Professional-type Organizations

So much for the union concept. Getting along to the comparison between the philosophies of a truly professional man and the union concept, let us consider some of the stated objectives of groups which are known for their professional-type activity. There are a number of organizations which accept the professional concept of engineering and have established their objectives and principles accordingly. Four which operate on a national scale and across all of the branches of the profession are:

Engineers Council for Professional Development
American Society for Engineering Education
Engineers Joint Council
National Society of Professional Engineers

In addition, certain local associations exist entirely within specific industrial companies employing large numbers of engineers. These are the so-called sounding-board groups:

Consolidated Edison Forum
Bell Telephone Laboratories Conference
Humble Oil Society
General Electric Engineers Associations

Comparison of NSPE–ESA Objectives

The objectives of these professional societies and associations are stated, in part, in words and phrases that have been parroted by ESA. For example, the National Society of Professional Engineers was organized with the objectives of—

> The advancement of the public welfare and the promotion of the professional, social and economic interests of the professional engineer.

ESA changed this only slightly, advancing the economic considerations ahead of the professional and social, leaving out any concern for the public.

One other important professional group, the Engineers Council for Professional Development, has this objective—

> To coordinate and promote efforts to higher professional standards of education practice, greater solidarity of the engineering profession and greater effectiveness in dealing with technical, economic and social problems.

Professional Society Objectives Require Close Coordination of Experiences at All Levels of Development

While the ESA statement of objectives and those of the professional societies may read somewhat alike, ESA's concepts of the individual engineer's position in economic and social matters differ materially. Their visualizations of the goal and descriptions of the road are different. So now the picture of the basic problem is coming into focus.

The final goal of the individual engineer starting to climb the ladder to professionalism may appear to be the same whether he takes the road to unionism or to true professionalism. Actually these roads lead to entirely different terminals of material and mental value, coloring the objective along the way. And so, a dividing point in the choice of groups is at hand. Shall the young engineer be guided from non-supervisory to supervisory level by labor union leadership, or shall he be encouraged and helped upward through his pre-professional training period by the older, more experienced engineers who have reached full professional stature?

The ability to make an intelligent choice between two such alternatives re-

quires that engineers, both young and older, have a sound knowledge of the characteristics and advantages of a profession, as contrasted to those of a union. Let us review some of the concepts of a professional man.

The Professional Philosophy

First, what is a profession? A profession has: basic characteristics, group attributes, principles of social duty, individual associations and recognized obligations.

The *basic characteristics*—

An attitude of mind—an altruistic motive can lift an honorable calling to the professional level.
A kind of work—special skill on a high intellectual plane.
An order in society—the bar, bench or clergy.
A confidential relationship—the doctor and his patient, or the lawyer and his client.

The *group attributes*—

A body of knowledge, held as a common possession and extended by united effort.
An educational process, to be guarded diligently.
A monopoly granted by the public, on a self-governing basis.

The *principles of social duty*—

Guarding the ideals and standards of the profession.
Advancing the profession in public understanding and esteem.
Sharing advances in technical knowledge.
Rendering free public service.
Bringing group knowledge to public and civic problems.
Establishing a substantial voice in public policies.

The *individual associations*—

A type of activity, motivated by a feeling of high individual responsibility and requiring special skill applied on a distinctly intellectual plane.
A motive of service, based upon limited rewards apart from profit.
A standard of personal qualifications, requiring character, training and proved competence.
A standard of conduct, recognizing courtesy, honor and ethics.
A motive of self-expression, joy and pride in the work and a self-imposed standard of excellence.

The *recognized obligations*—

Service above gain.
Excellence above mediocrity.
Pride above monetary reward.
Loyalty above individual advantage.

Dr. Steinman's Summation

These points were well summarized and related to the collective bargaining concept by Dr. David B. Steinman, first President of NSPE, when he said:

The usual methods of unions (coercion, strikes, picketing, closed shop, etc.) should be unthinkable in a profession. Such methods are inconsistent with all of the ethical ideals of a profession.

Engineers occupy a position of confidence and trust between capital and labor, and between employers and employees. Unionization is inconsistent with the highest discharge of that trust.

Unionization places the sole emphasis on wages and hours, and on union membership, instead of emphasizing qualifications and quality of service.

Unionization tends to pull all members of a profession down to the same level, discouraging individual effort, loyalty and ambition.

Unionization is identified with the trades. Unionization of engineers undoes the work of years in winning public recognition of engineering as a profession.

Unionization is inconsistent with the professional spirit and attitude, which places service before profit, the honor and standing of the profession before personal advantage, and the public welfare above all other considerations.

Harmful Effects of the Collective Bargaining Concept

Summarizing the harm engineering unions can do us as individuals and as a profession:

First, for engineers as individuals:

There would be a classification of engineering positions, with minimum standards.

Initiative would be discouraged, individual recognition stifled, opportunities limited, and advancement retarded.

Personal prestige would be damaged and professional recognition diminished.

A "leveling" of salaries would result, and regimentation would follow.

Second, for the engineering profession as a whole:

The desire for higher intellectual attainments would be sacrificed to the concern for immediate advantages.

The confidential relationships inherent in professional service would be lost in the hypocrisy of lip service.

Stratification, fragmentation and splintering of the profession would continue.

Proper Education Needed to Stem the Collective Bargaining Trend

A more important question which must be answered, however, is: "Where do we go from here?" To be truly helpful in this situation, we must be able to recommend to the engineering profession a course of action designed to counteract effectively the challenge of unionism. With long-range vision of the problem, NSPE took its first major step by adopting a Statement of Principles in June, 1950, reaffirmed in November, 1952, which reads as follows:

It is definitely unprofessional for a professional engineer, professionally employed, VOLUNTARILY to join a heterogeneous labor union, dominated by, or obligated to, nonprofessional groups. As stated by the Society, through its Board of Directors at Oklahoma City in September, 1948, "The individual responsibility and independent judgment required of a professional engineer are incompatible with the regimentation fundamentally inherent in unionization."

In further answer to the question, I suggest vigorous support of a three-level program of education directed toward *engineering employees, engineering management,* and *engineering students.* Let us consider how each of these groups can participate and contribute its proportionate share toward a satisfactory solution of the problem.

Engineering Employees' Development

First, *engineering employees,* as individuals, must continue to develop professional vision according to the concepts outlined above in the discussion on what constituted a profession. A public statement emphasizing this was made only recently by Mr. T. Carr Forrest, Jr., President of NSPE, who expressed the following viewpoint:

In a large eastern newspaper of recent date there appeared the headline, "RCA Engineers Announce Strike." In the same newspaper, the next day, "RCA Engineers Call Off Strike." Here was a case where a union of professional people (and the word 'professional' is in the title of the union name) calling upon their weapon of last resort to force their point of view. Regardless of the particular issues in that situation, can professional people go before the public one day in terms of strikes and picket lines, such as are used by production workers, and go before the public another day, as we do during Engineers' Week and upon other occasions, talking of public service and asking the public to bestow their blessing and recognition on us as a professional body entitled to that public distinction because of our endeavors to obtain advanced knowledge for the public good as well as our own good?

One of the obvious hallmarks of professionalism is individualism and the right

to make one's own way in improvement in the economic ladder, and certainly, at least in the professional ladder. This agreement (between RCA Engineers and Management) may be to the economic advantage of the engineers for whom it was negotiated, but I maintain that when an individual professional engineer is 'represented' by force of law and collective bargaining agreement to the extent of almost every phase, detail and aspect of his daily professional activities, it cannot be successfully maintained that collective bargaining is compatible with his status as a professional man. If your professional development and advancement are to be regulated in 35 ways as part of your daily activities, you may or may not climb the professional ladder, but you will climb it, if at all, only on the rungs which are contained in the 'agreement' and you will climb it no faster than the 'agreement' permits.

Engineering Managements' Development

Second, *engineering managements* must be informed to the point of obtaining a full understanding of the problem and an appreciation of the consequences inherent in the alternatives. Specific thoughts in this vein were expressed by the late Dr. Karl B. McEachron of the General Electric Company, in a letter dated October 5, 1953:

> As I see it, it is highly important that management take time off to find out what their engineers can do for them in terms of satisfying accomplishments. While there will be some cases where the engineer can be completely a lone worker, in the majority of cases he is going to require a certain amount of assistance of various kinds or else we are going to waste his talents and training. Obviously many engineers do not get in this position in the first year or two but certainly for most of them inside of the first four or five years they ought to be in a position where they have grown enough so that their contribution should be a significant one, and if conditions are right, a continuing one. Personally, I think the employer is the key to this whole situation, and when I say 'employer' I mean not only the employer in industry but I mean the administration of our colleges, professors, and others, and the client who employs an engineer or a consulting firm to do work for him; also, of course, the municipal, state and governmental agencies as well.

Managements Are Making Good Progress

It is truly encouraging to know that the managements of some corporations employing large numbers of engineers, scientists and technicians, have recognized the problem and are carrying out detailed and specific programs of mutual education. The purposes and characters of these programs are many, but they all are directed toward the establishment of mutual understanding and cooperation between management and the engineer as a professional employee. Some of the more important of these industrial programs are:

- Adequate orientation, including a complete explanation of company policies and procedures.
- Opportunity for personal development through further education, adequate training, professional registration, effective speaking and the preparation of technical articles and special reports.
- Enlightened salary administration through frequent appraisal and rating of the individuals.
- Recognition of educational attainments and technical proficiency.
- Utilization of professional personnel in appropriate capacities and for work of engineering character. Provision of adequate opportunity for advancement.
- Sponsoring membership in professional and technical societies. Sponsoring registration, and assisting in the development of refresher courses. Encouraging participation in community affairs.

While the task of management appears monumental, actually it can be overdone, as pointed out by Mr. Clark Ransom of General Electric Company, who addressed the annual meeting of NSPE

at Daytona Beach, Florida, in June, 1953, on the subject of "The Professional Development of Engineers and Scientists in Industry." Mr. Ransom spoke as follows:

Some of you may be raising the question, 'Why does not the employer assume responsibility for the professional development of the engineering and scientific personnel?' Management *is* contributing to the broader career development of these people. I am sure that there is more that management can and will do. But there are areas in the field of professional development which are not the responsibility of the employer. A paternalistic employer who 'holds the hands' of the engineer and does his thinking for him is encouraging dependency and incompetency. Such practices can be just as damaging as the regimentation imposed by collective bargaining.

Engineering Students' Development

As the third and equally important phase of this program, the *engineering students* must be exposed to the need for making an ultimate choice between unionism and professionalism. Here is the way an outstanding educator, Dean W. R. Woolrich of the University of Texas and Past President of the American Society for Engineering Education, sees the situation:

The answer to either the students of the engineering colleges or to the man who plans to grow is not unionism. The reward for which the professional engineer strives is a composite of full recognition and appreciation for the manpower product of the engineering colleges by those who employ, advise and direct.

The future of engineering as a profession in North America depends upon the ability of the engineering colleges to advance their education to new levels of professional achievement. The *incentive* for both students of engineering and the engineering colleges, however, is in the hands of those who direct the progress of the graduates after they leave the college halls.

The future is not too bright in collective bargaining for advancement of men of creative genius and individual professional abilities. Collective bargaining is never inspirational to the man of creative talents, and recognition cannot be readily afforded him other than as a part of a collective group.

The Engineers Joint Council, The Engineers' Council for Professional Development and the National Society of Professional Engineers now face the alternative of speeding up their coordinated effort to improve the professional status of the recognized engineer or giving way to a less discriminating group of union engineers who would like to speak for all of us on the workman's side of the collective bargaining conference table.

NSPE Is Already Active in Supporting the Professional Attitude

You should know that *your* professional society is contributing much toward the solution of this problem by education at the three levels specified. NSPE has a broad program directed toward engineering employees, managements and students, which is well under way in many of its phases. The details of these programs are too numerous to present here, but your attention is directed toward the current work and official reports of committees, as follows —with Chairman and State location to indicate country-wide consideration:

Employment Practices—Mr. Alfred J. Ryan, Chairman (Colorado)

Education—Dean W. R. Woolrich, Chairman (Texas)

Young Engineers—Prof. E. W. Carleton, Chairman (Missouri)

Public Relations (including National Engineers' Week)—Mr. E. W. Seeger, Chairman (Wisconsin)

Professional Engineers Conference Board for Industry—Mr. John D. Coleman, Chairman (Ohio)

These executive research survey reports already issued:

(1) How to Improve The Engineering-Management Communications

(2) How To Improve The Utilization of Engineering Manpower
(3) How To Attract and Hold Engineering Talent

Special Industry Committee—Mr. R. A. Blackburn, Chairman (Pennsylvania)

The Head-on Collision of Philosophies

The history of engineering is one of grand achievement. Public recognition of the value of the profession has been based upon the intimate knowledge and experience of the man in the street, of the ways in which the engineers' plans, developments and products have made life more pleasant and more profitable. Much of the public's appreciation has stemmed from the certainty that mechanization and production line methods have, time and again, multiplied the numbers of jobs available.

Thus, the engineering profession has earned its present degree of public esteem on the basis that it "makes work"—useful work. In the face of this proved formula for enhancing our professional reputation, those who would have engineers bargain collectively as a means of economic gain have advocated work stoppages as the means for attaining their ends. It is my conviction that the profession would lose immeasurably, and you and I would suffer significantly, were we to change in the slightest our tried and true approach to the further enhancement of the profession, and to your and my self-satisfaction.

The Contradiction Is Clear

As a conclusion to this presentation of the contrasting philosophies of collective bargaining groups and professional engineering organizations, let us emphasize our confidence in professionalism as a way of life in engineering by quoting the well-known and thought-provoking words of the late Dr. William E. Wickenden, who wrote:

> Every calling has its mile of compulsion, its daily round of tasks and duties, its standard of honest craftmanship, its code of man-to-man relations, which one must cover if he is to survive.

I break in at this point to concede willingly that the union concept is not in violent disagreement with Dr. Wickenden's remarks thus far, which pertain to man's selfish motives. However, the professional concept, and the great contradiction to the collective bargaining philosophy, is emphasized by these words:

> Beyond that lies the mile of voluntary effort, where men strive for excellence, give unrequited service to the common good, and seek to invest their work with a wide and enduring significance.
>
> It is *only* in this second mile that a calling may attain to the dignity and distinction of a profession.

The parting of the way is immediately ahead—down the road to unionism, up to professionalism. The upper road, figuratively and literally, is a harder route, but amply rewarding in the vastly improved outlook for a lifetime devoted to the advancement of the engineering profession.

Let's Take Another Look at the Causes for Professional Bargaining Groups

By A. A. K. BOOTH

Director, ASCE

The Taft-Hartley Act provides a statutory definition of a professional employee and establishes principles under which such individuals may form a unit for collective bargaining purposes, or may join any other unit for the same purposes, or may even refrain from participating in collective bargaining. The Board that administers the Act is under no obligation to police the contracts so it is the responsibility of professionals to be aware of their prerogatives under the Act to ensure to themselves the prerogatives granted by the Act. The Act does not vindicate the action of a professional group. It merely affirms their legal rights.

The Act states in Section 9(b) that:

The Board shall decide in each case whether, in order to assure to employees the fullest freedom in exercising the rights guaranteed by this Act, the unit appropriate shall be the employer unit, craft unit, plant unit or subdivision thereof: PROVIDED that the Board *shall not* (1) *decide* that *any unit is appropriate* for such purposes if such unit *includes both professional employees and employees who are not professional employees unless* a majority of such *professional employees vote for inclusion in such unit.*

By statutory definition a "professional employee" is an individual who has "knowledge of an advanced type in a field of science or learning customarily acquired by a *prolonged course* of *specialized intellectual instruction and study in an institution of higher learning* or a hospital as distinguished from a general academic education or from an apprenticeship or from training in the performance of routine mental, manual or physical processes." It is clear that the professional employee is no ordinary person: it is equally clear that he must have, except in exceptional cases, a substantial professional education in an institution of higher learning.

Engineering educators must then view with concern any move by professionals to join by their own volition with nonprofessionals in units for collective bargaining purposes. Something must be wrong when this occurs.

T. H. Evans, Dean of Engineering, Colorado A and M. College, suggests in his paper "Let's Look at the Causes for Professional Bargaining Groups" (1) a possible difficulty. Dissatisfaction with a Plan, Plan "A"—one of the four of the so-called Plans A, B, C and D, prepared by task committees of the Exploratory Group representing fifteen National Engineering Societies interested in a Unity Organization for Engineers. He suggests that dissatisfaction with the Unity Organization developed under Plan "A" caused professionals to seek elsewhere for a suitable home. He suggests that they found an acceptable home in the Engineers and Scientists of America which, to use his words, is "merely a national federation of member units set up to handle employer-employee relations." Let us take a quick look at two of the organizations that have affiliated with the E.S.A.

The Engineers Association at Sperry, composed, to quote Joseph Amann, President, E.S.A., of "professionals" affiliated with E.S.A. The Association was on strike quite recently. It placed an advertisement in the *New York Times* of March 11, 1954, demanding among other things, "a contract incorporating legitimate gains that have been granted to *all other unions*, such as union security and job security. The Engineers' Association of Arma, Brooklyn, N. Y., is also affiliated with the E.S.A. It conducted a strike last summer. It *honored* the *picket lines* of the C.I.O. International Union of Electrical, Radio and Machine Workers.

Non-Professional Tactics

Both Associations adapted tactics that resemble closely those followed by non-professionals. Their actions raise two questions. First, would the task committees representing the fifteen national engineering societies have designed a Unity Organization that could tolerate non-professional conduct? Second, did any of the plans—A, B, C or D—envision a Unity Organization with which the Engineers' Association at Sperry or the Engineers' Association of Arma would care to affiliate?

There seems little doubt but that the answer to the first question must be NO and reasonable belief in that the answer to the second question would also be NO. And "NO" in both cases because of the gulf that exists between professional and non-professional practices.

The Professional Engineer is defined by the Taft-Hartley Act and more elaborately by the conferees at the conference of the Engineering Societies of Western Europe and the U.S.A. (EUSEC) that met in Paris in September of 1953. Under the Act the professional engineer is one who having the education and experience aleady referred to is "engaged in work predominantly intellectual and varied in character," that involves "the consistent exercise of discretion and judgment," and is "of such a character that the output produced or the results accomplished can not be standardized." It clearly describes an individual whose economic lot is not susceptible to determination on a collectivized basis. The EUSEC conferees in Paris in 1953 merely clarify the statements about the Professional in the Act by adding that the "professional engineer is competent by virtue of his fundamental education and training to apply the scientific method and outlook to the analysis and solution of engineering problems"; that the professional has an education which will "make him capable of closely and continuously following progress in his branch of engineering science by consulting newly published work on a worldwide basis, assimilating such information and applying it independently"; that the professional is in a "position to make contributions to the development of engineering science or its applications"; and is thus able to "assume personal responsibility for the development and application of engineering science and knowledge, notably in research, designing, construction, manufacturing, superintending, managing and in engineering education."

It seems reasonable to believe that such individuals would seek an organization in which there is a "solidarity of interests, objectives, standards and responsibilities" (2) to use the words of Thomas A. Marshall, Jr., Secretary, Engineers Joint Council, but that they would be unfavorably disposed to the idea of collective bargaining to establish or improve their economic lot.

The EUSEC conferees do further service to all interested in recognizing the professional engineer by defining the Engineering Technician as one "who can apply in a responsible manner proven techniques which are commonly understood by those who are expert in a branch of engineering or those techniques specialy prescribed by professional engi-

neers," and who in performing their duties will have "supervision of the work of skilled craftsmen."

Can it be that we have failed to recognize the distinction between a professional engineer and an engineering technician? Between the professional and non-professional? Are we dead sure that professionals in the full sense of the Act and the definition of EUSEC are actually involved in collective bargaining?

Clear Distinction

In the spirit of Taft-Hartley there is a clear distinction between these groups. There is even a fine distinction between the professional intern and the non-professional. But this, and even the definitions of EUSEC regardless of their clarity, is all worthless if there is a lack of professional spirit in those that qualify as professionals. Perhaps engineering educators have failed in some measure and that the words of Sir Lionel Whitby at the First Conference on Medical Education in London last August are worth closer study. In his speech on "The Challenge in Medical Education" (3) he asks of the medical teachers if "those in control of medical education will really have the humility and courage to admit that all is not at its best in the best of all possible worlds, their worlds," and again "if those *who hold the shaping of the future in their hands will fashion it with vision and imagination so as to inspire the young man and woman to pursue the tasks of our great profession with a feeling of dedication to something greater than themselves.*" Is not this spirit of dedication needed if professionals are to give meaning and utility to their Unity Organization? Is not this spirit of dedication the cohesive element that will give them the stature they seek.

But while engineering educators may be to blame for having failed to inspire in their students a spirit of dedication to the professional cause let us not forget that others have a hand in molding the intern. It may be that the misuse of professionally trained personnel is equally responsible for this lack of professionalism in their conduct. Perhaps a re-appraisal of the duties of the professional will show that much now considered to be within the domain of the professional really falls within the province of the non-professional.

Such re-appraisals are not easy to make or once made to effectuate. But they are necessary if all concerned wish to taken another look at the reasons for professional (?) bargaining groups. Such re-appraisals may even affect the number of engineering schools now in existence. Such reappraisals will certainly affect the curriculum of the professional schools and bring into being a much larger group of institutions whose interests are with the engineering technicians.

Another look, and still another look at the reasons for professional (?) bargaining groups is urgently needed. The result of the many "looks" will not materialize overnight, or within the next five or ten years. But they are needed if we are to have the Professional Engineers that our country needs.

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Some Methods and Techniques Used by the Armed Services That Colleges Might Well Examine*

By CLYDE R. NICHOLS

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For the past several years we have been giving an ever increasing attention to such questions as:

1. How can we do a better job of teaching.
2. How can we encourage and help develop the more capable student? ASEE has several committees who are making some searching studies trying to find the answers. In this search may I suggest a few methods and techniques used by the Armed Services that Colleges might well examine. In trying to find how we can do a better job of teaching and how we can help the more capable student let us look at what the Armed Services are doing with:

1. Instructor training and preparation.
2. The use of supervisory check sheets.
3. Scheduling only one subject at a time.
4. Sectionalizing on the basis of ability.

The gigantic training effort necessitated by World War II is easy to recall. More than 18,000,000 service personnel were trained and over 2000 specialists schools were established. A very large instructional staff had to be assembled and trained. Virtually the only source of obtaining those new instructors was from the graduates of the various schools. The students who made the best grades were retained as instructors. How similar to the manner in which college instructors are chosen today and have been chosen for decades. Each Service School had to develop an INSTRUCTOR TRAINING program peculiar to its own needs and as best it could. As time went along specialists in educational methods, psychology, speech, and training aids, were brought in to develop those instructor training programs. By the end of WW II some excellent instructor training schools existed, and a few have been continued and improved to the very present. One of the better, if not the best, is the two weeks course in instructor training put on by the Armed School at Fort Knox, Ky. The Army sends men from all over the U. S. to take this course, and I have just returned from attending it. Instruction is given in the following subjects:

1. Principles of learning
2. Fundamentals of instruction
3. Presenting oral instruction
4. Speech techniques
5. Training Aids
6. Planning the lesson
7. The lesson plan
8. Presentation by the lecture, conference and demonstration methods
9. Questioning techniques
10. How to conduct a critique

*A paper presented to the Educational Methods and Electrical Engineering Divisions of ASEE at the annual meeting of the Society, held at the University of Illinois, Urbana, Ill., on 16 June 1954.

11. Test construction
12. The supervisory check sheet
13. Problems in organizing and administering an instructor training school

The Military and Naval Academies, the Command and General Staff College, the Army, Navy and Air Force War Colleges, and all the Service Schools operate very special instructor training courses during the summer for all newly assigned instructors. These include a course similar to the one at Fort Knox, followed by study, preparation of lesson plans, running laboratory exercises and preparing demonstrations and training aids in the actual course work or subjects in which they are to give instruction.

In 1930 I was hired by Purdue (on the basis of good grades) to report on September 15th. I actually reported on the first of September. The late Prof. C. F. Harding, then head of the E. E. School, asked why I was there so early? I told him I wanted to get a textbook and begin preparing the lessons I was to teach, and wanted to go into the laboratory and run the experiments so I would know what was going to happen when I told a boy to do something. He leaned back in his chair and said he had been head of the E. E. School 22 years and this was the first time this had ever happened, and he thought it was a pretty good idea. In the 24 years since, I am unaware of anyone reporting early for the same purpose, although I have not been in a position to know.

We all know that a high school teacher, or a grade school teacher, or even a kindergarten teacher has to have all sorts of special training to be qualified to teach. But how many of you ever heard of any special training required to be a college engineering instructor? If we want to improve instruction in colleges, isn't it about time we considered a few instructing techniques in addition to how well the instructor knows his subject? Can you imagine the effects on instruction if new instructors were hired on a 12-months basis for the first year, to begin in July with a training and preparation program similar to that at the Service Academies? What would a 10-day or 2-weeks methods of instruction course, followed by 6 to 8 weeks of specific study, preparation of lessons, running laboratory exercises and preparing demonstrations and training aids in the subjects the new instructor is going to teach, do to the quality of instruction in these subjects? And incidentally, if such employment could be had during the summer following graduation, might not colleges be in a more favorable competitive position with industry in securing potential instructor personnel initially? However, if budget limitations prevents the hiring of new instructors on a 12-months basis the first year, what is there to prevent us from bringing the new instructors together near the first of September for a 10-day or 2-weeks methods of instruction course? We have to pay them for the first part of September anyway—why not use this time to a better advantage?

Instructor Evaluation

Now let us turn our attention to the "Supervisory Check Sheet." All the Services are using some form of supervisory check sheet on every instructor in the service. If you have ROTC in your college you can check with them as to the specific form they use, and the attitude among the instructors about its use. The supervisory check sheet that is used at the Armored School at Fort Knox (shown below) consists of a cardboard printed on both sides. On one side we see the directions for using the check sheet; a place to list the instructor's major strengths; and a space to list the supervisor's (or observer's) recommendations for improvement. On the other side are eight elements (of good instruction) to be rated, with a number of subtopics under each element.

THE ARMORED SCHOOL
Fort Knox, Kentucky

SUPERVISORY CHECK SHEET

NAME _____ CLASS OR DEPT _____

INSTRUCTOR _____ CLASS OR DEPT _____

TITLE OF LESSON _____ FILE NR _____

REPORT SUBMITTED BY _____ RATING _____

CRITIC _____ RATING _____

DIRECTIONS: 1. Rate subtopics under Elements To Be Rated as follows:

\+ Plus for performance above average.

✓ Check for performance which is average.

Minus for performance below average.

2. Rate each Element To Be Rated on the Rating Scale by circling the number which best describes the over-all performance for that element. The numbers have the following meanings:

6. Outstanding	3. Very Satisfactory
5. Superior	2. Satisfactory
4. Excellent	1. Unsatisfactory

3. Write comments to justify your rating of each element of the lesson. List major strengths and make recommendations for improvement.

MAJOR STRENGTHS

RECOMMENDATIONS FOR IMPROVEMENT

In using this check sheet the subtopics will be rated by placing a plus mark in the box for performance above average; a checkmark in the box for performance which is average; and a minus sign for performance below average. Then the element as a whole is rated on the rating scale by circling the number (or using a checkmark along the scale) which best describes the overall performance for that element. The numbers along the scale have the meaning: outstanding, superior, excellent, very satisfactory, satisfactory, and unsatisfactory. Next, comments to justify the rating given each element is placed under each scale.

Where possible, observers experienced in methods of instruction, will be used to fill out the check sheet, with the objective of making a fair evaluation of the instructor's performance, and offering constructive suggestions for improve-

ELEMENTS TO BE RATED		RATING SCALE
INTRODUCTION		
Objective	☐	6 | 5 | 4 | 3 | 2 | 1
Reasons	☐	
Contact	☐	
Interest	☐	
EXPLANATION—DEMONSTRATION		
Organization Easy to Follow	☐	6 | 5 | 4 | 3 | 2 | 1
Clear Explanation of Points	☐	
Emphasis of Key Points	☐	
Material Vitalized	☐	
Transitions	☐	
Summaries	☐	
Demonstration	☐	
INSTRUCTOR QUALITIES		
Appearance & Bearing	☐	6 | 5 | 4 | 3 | 2 | 1
Poise & Confidence	☐	
Mannerisms	☐	
SPEECH TECHNIQUES		
Volume—Use of PA	☐	6 | 5 | 4 | 3 | 2 | 1
Rate	☐	
Fluency	☐	
Phraseology & Usage	☐	
Contact with Class	☐	
Force & Enthusiasm	☐	
Enunciation & Pronunciation	☐	
Gestures	☐	
USE OF TRAINING AIDS		
Selection of Aids	☐	6 | 5 | 4 | 3 | 2 | 1
Use of Aids	☐	
Use of Pointer	☐	
Smoothness	☐	
Blackboard Work	☐	
CLASS PARTICIPATION		
Student Participation	☐	6 | 5 | 4 | 3 | 2 | 1
Characteristics of Questions	☐	
Techniques	☐	
Answers to Student Questions	☐	
Application	☐	
Examination	☐	
DISCUSSION & CRITIQUE		
Questions Cleared Up	☐	6 | 5 | 4 | 3 | 2 | 1
Summary	☐	
Closing Statement	☐	
PREPARATION		
Command of Subject	☐	6 | 5 | 4 | 3 | 2 | 1
General Plan for Lesson	☐	
Material on Level of Class	☐	
Signs of Rehearsal	☐	
Timing	☐	

Assigned Length_____Min Time Start_____ Time End_____ Total_____Min

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ment. When an experienced observer is not available, the instructor's immediate supervisor or those higher up, make out the check sheet as best they can, but with the same objectives. And it does not take too long to develop to the point where a great amount of help can be given to the instructor, especially if he is a new one. The observer or supervisor never interrupts the class or instruction in any manner. Rather, a private after-action critique is held. This routine is followed until the new instructor becomes fairly confident and experienced. Afterwards, only an occasional visit is made to keep the instructor on his toes, or when the instructor requests a check be made in order to help him. When the instructor sees and studies the items and ratings and recommendations on the completed check sheet he realizes that it is all being done in order to help him improve, and he actually welcomes the visits of the supervisors. I have seen many new instructors request fellow instructors to monitor their work and make recommendations for improvement. However, they want a check sheet used, for it is specific and objective—they are not interested in opinions without foundation.

How many of us in the college teaching game have ever had a supervisor or a head of a department visit our classes in order to find out first hand how we are doing, or to offer constructive suggestions for our improvement? Many were the times during my first few years that I longed for someone to visit my classes in order that they might help me. I still would welcome a visit, although I am pretty well set in my ways now. How many of us have ever had rating sheets made out by fellow instructors that would help improve our methods and techniques? May I suggest the honest belief that the efficient use of supervisory check sheets will help improve the instruction of beginners no end, and that once the objective is understood, the beginner will actually request the supervisor to use the check sheet.

Techniques for the Capable Student

Now let us see if the Armed Services have any methods or techniques that are designed to help advance the more capable student? First, virtually all the Service Schools operate on the premise that more information and education can be accomplished in the minimum time by concentrating on one subject at a time. When several subjects are to be studied at the same school only one or two are taken concurrently. In the Coast Artillery School and the Antiaircraft Officer Candidate School where I worked two years, there were seven different subjects studied over a three months period. These were taken one at a time for periods of one to two weeks each. One of these, for example, was trigonometry, using a standard college text. The students went to class eight hours per day for five and one-half days. Approximately three hours each day was devoted to instructor presentation, and the rest was application and supervised study. Then there was three hours of study per night for six nights, with an instructor present to help when needed. Experience taught that more subject matter could be covered and more retained by this approach to a series of subjects. At West Point, where I taught four years, never more than two major subjects were scheduled concurrently. This same idea is used to a limited extent by those colleges that operate on the "quarter" plan. What do you think you could accomplish in a course if you met class for two or three hours each day and had a self-contained laboratory five days per week for three weeks? Especially, when there are no other subjects to divide your efforts and attention between? I believe I learned more in two weeks at Fort Knox about one subject than I have ever learned in a 3-credit graduate school course scattered out over 16 or 17 weeks and all mixed up with a lot of other courses at the same time. One wonders if some day some College may be brave enough to break with the

tradition of taking five concurrent courses per semester and schedule one subject at a time for five consecutive three-week periods? And incidentally, how much additional time would a student need to make up a single course failed somewhere along the line? And how long would he have to wait to begin the repeat of the course after he did fail it?

The second technique used to help the outstanding student is that of sectionalizing on the basis of ability. West Point and Annapolis have long been the outstanding examples of this technique. All students start on an equal basis. At the end of each four to six weeks they are sectionalized on the basis of their accumulated grades to that date. This is done throughout the entire four years. By the time they reach their junior and senior years they really have all the capable ones together in the top sections. The upper sections are given additional study assignments, employ more difficult and theoretical texts, and are required to make more extended investigations in the laboratories than are the lower sections. The most brilliant and fastest thinking faculty members are assigned as instructors of these upper sections. Experienced instructors recognized as being thorough and capable of instructing the "plodders" are assigned to the lower sections. It is found that this makes for the finest teamwork possible. No one is impatient of the other fellow for being too fast or too slow. The instructor is not above the level of some nor below the level of others. No one loafs and all are continually challenged to their capacity in order to remain in the upper sections. Could colleges and universities sectionalize on the basis of ability? With the myriad of curricula, courses, efficient utilization of laboratory facilities, and personal matters of individuals involved, it is questioned that too much could be done except at the beginning of each semester or quarter? But what have we done with the accumulative grade-point indices after the freshman year to date? This past semester at Purdue we had ten sections of second semester sophomores in Electrical Engineering with grades ranging from A to F in each of the ten sections. Would sectionalizing on the basis of grade-point indices enable us to better promote and develop the more capable along the lines of advanced theory, research and highly specialized training, faster and more thoroughly; and at the same time permit more attention to the generalized and vocational training of the slower group? Why does West Point, with its basic General Engineering curriculum of fundamentals, rank fourth in the Nation in the number of Rhoades Scholars? Why do their graduates come to our colleges and make the very top grades in our graduate schools?

Summary

In summary, in our search to improve our teaching, let us consider the possibility of:

1. Instituing instructor training courses for new instructors.
2. Beginning extensive use of supervisory check sheets.

And in trying to help develop the more capable students let us consider:

3. Scheduling only one subject at a time.
4. Scrutinizing more carefully the advantages to be gained by sectionalizing on the basis of ability.

Twenty-four years ago I had an honor student tell me that a new instructor wasn't worth a tinker's damn. I have heard some such remark at least once a year ever since. I heard a panel discussion in Chicago wherein each College in the Illinois-Indiana Section of ASEE was worrying about the quality of instruction received from the inexperienced instructors handling non-electrical courses. I suggest we have a REAL challange. And I for one, am going to try to meet this challange in a small way by attempting to develop an instructor training course for new engineering instructors, and sell them on the idea of using the supervisory check sheets.

Teaching Design by Motivation*

By LEE HARRISBERGER

Assistant Professor of Mechanical Engineering, North Carolina State College †

Design is generally regarded as an ability which must be learned by years of industrial apprenticeship. However, design can be taught. There are several basic ideas that may be used in an approach to teaching design. First, the student must become conscious of the value of the line of attack. Second, he must be trained to become critical, to challenge every idea, to be on the lookout for other ways, and to compare, weigh and discard. Third, he must be taught to make decisions—boil the ideas down. Fourth, he must be taught to coordinate all the influencing factors affecting or being affected by the design.

The first three years in engineering are devoted to fundamental concepts and rigorous exercise in the use of these concepts in problem situations. Somewhere in the fourth year the student should begin to learn to think in terms of whole problems—to begin to develop an analytical approach to an unknown situation which has no immediate answer nor even a real definition. But above all, he must begin to develop a mature engineering attitude with confidence in his capacity.

In the senior machine design course last year at the University of Utah, an experiment was conducted to test this approach—this philosophy for teaching a design course. The teaching motive was borrowed from Confucius: ". . . do not pull the student along, open the way but do not lead him to the place . . . let the students admire the excellence of other students."

The formal lecture sessions were separated in plan and action from the laboratory sessions. The lectures were designed to emphasize the importance of good design decision and rational analysis. Stress determination was not played up as the primary function of the designer. The attempt was directed toward developing in the student an attitude of awareness of the importance of all things in a complete engineering design.

The laboratory portion of the course was the crux of the whole new scheme. For one thing, it caused the lectures to "hit the nail on the head" for the student Most of the battle is won for the lecture instructor when the student has discovered how important it is for him to know what is being discussed. In the laboratory program an attempt was made to adhere to two fundamental goals in teaching: to generate within the student a burning enthusiasm, and to force the student to self-motivated activity. One is a function of the other. A student is a dynamo of self-motivated action when he becomes enthusiastic.

Enthusiasm seems to be a natural product of immaturity. Man from his childhood has a basic drive to seek new adventure and new experience. It is the motivator toward his maturity. Children are enthusiastic about everything new because it is a new experience and satisfies their urge to master new skills. The senior student is eager to have a try at doing some engineering on his own—try out his new skill. He wants to test his technical strength, and he enjoys the competition of his fellow students be-

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*Condensed from a paper presented at the Rocky Mountain Section meeting, ASEE, at University of Utah.

† Formerly at University of Utah.

cause it serves to gauge this technical strength. Give him these two opportunities and his natural enthusiasm for the adventure is boundless.

Cut Them Loose

A system was devised to put the students on their own—cut them loose from the instructor's apron strings. They were given the adventure of a "solo flight." They were put in an environment of competitive engineering activity that forced them to rely entirely on their own capacity. They were given a challenge and their enthusiasm was amazing.

The class was divided into eight-man teams. Students of strong leadership ability were chosen by the instructor to be the "Chief Engineer" of each team. Each "Chief Engineer" chose his team by a system of "choose-up" so that each team would have its share of capable talent. These teams were designated as consulting engineering firms . . . they even chose a name for their company. Each company was to compete for acceptance of a bid proposal for a design published by a fictitious company in the East. The bid request outlined a need for a competitive design of a moderately complex product the fictitious company wanted to manufacture and market. The specifications outlined in the bid request were based only on what would attract a particular sales market. The students had nothing more to go on than general requirements for capacity, endurance, saleability, safety, and cost. No requests were made for a particular design, material, size, weight, or cost. The bid requested that the competitive proposal be in manuscript form including pictorial illustrations (assemblies and breakdowns in perspective), cost analysis, complete specifications, detailed stress analysis, and manufacturing specifications.

Each consulting firm was to prepare a complete bid on reproducing masters and provide a copy for each member of the class. After the bids were prepared, two engineers from industry and an M.E. staff member were invited as consultants to represent the company that called for the bids. Each student "Chief Engineer" had to present his firm's design before the whole class and the panel of consultants. Since all the competing consulting firms had copies of each bid, they had an opportunity to review the competitive bids and use their criticism of them as arguments for their own case. Thus, each group was faced with the critical and devastating evaluation of the other groups. The panel selected and rated the bids in order of merit.

Academic evaluation of the student's performance for a grade was based on three things: First, each student was required to hand in a personal preliminary design which was graded as one measure of the individual's design conception. These preliminary designs were then used by the chief engineer and his staff to develop the competitive design. The second portion of the grade was based on the instructor's evaluation of the individual performance of each man for his company in the preparation of the details of the final design. The third portion was based on how well the student's company placed in the bid competition.

Perform at High Level

Never has a group of students taken such a genuine interest in a class. Competition was terrific. This competition forced the students to perform at a level far higher than the instructor could ever demand. They took it upon themselves to search the periodicals for new information, to talk to manufacturers, and to search for and learn techniques for solving special stress situations.

Several important and valuable training devices can be noted in this new approach to the teaching of design:

1. It stimulated the student and motivated him to take it upon himself to make his own decisions and search for information he did not have. He had to rely on his own resources to dig out stress and design techniques that had never been covered

in any class he had taken—just as he will have to do when he gets out in industry.

2. It put him into competition with his fellows on a technical plane rather than on an academic plane. He had to compete by virtue of his capacity to use his background and resourcefulness rather than his ability to master an academic hurdle such as an examination or homework assignment.
3. It created an environment of real engineering activity. It forced him to make decisions as to what was important in the design. It forced him to accept and reject ideas on the basis of a number of considerations. It made him compromise, analyze and come to a mature decision.
4. It gave the student an engineering sense of proportion. He had to consult with manufacturers to get the sense of costs and practicability.
5. Above all, it gave him a respect for his background and his own ability to conquer in an area where he had no previous experience.

This experiment showed a lot of potential and it showed that this type of teaching can be difficult. The teacher is no longer just an explainer, the man behind the pulpit. He becomes an administrator of the independent activities of each student. It is quite easy to expound facts and grade problems and examinations. It is more difficult to be a promotor, the big personality, the supreme enthusiast. In this new role he must continually set the pace, create and maintain the positive point of view, and help the student overcome discouragement when the going gets rough. He must guide their enthusiasm in the direction of maximum attainment. He plays the role of the professional consultant.

Design is not an art—it is the act of putting a lot of related facts together and making decisions as to which facts are important. To teach design is to teach thinking, reasoning, and self-reliance. Motivation is the key to learning. Therefore, give the student a mature challenge and his natural enthusiasm will motivate him to learn the most difficult of all—the ability to reason.

In the News

The forthcoming retirement of William N. Carey as Executive Secretary of the **American Society of Civil Engineers,** oldest national organization of engineers in the country, has been announced at the organization's headquarters in New York. The retirement will take effect May 1, 1955.

Col. Carey, former Chief Engineer of the Federal Works Agency and former City Engineer of St. Paul and distinguished in many fields of civil engineering, will become Secretary Emeritus. He will be succeeded by William H. Wisely, of Champaign, Illinois.

Requirements for Engineering in the Communications Operating Field*

By H. I. ROMNES

Chief Engineer, American Telephone and Telegraph Company

Engineering in all areas have this in common—they are all creative activities. The engineer in research and development creates designs for new tools to provide new, better or cheaper communications. The engineer in manufacturing creates the methods for making these tools—converts paper designs and laboratory models to commercial products. Some of these products, for example, television sets, then are ready for the ultimate consumer, but others are used by the engineer in the operating field to create communication service.

I emphasize the creative aspects of the operating engineering job because I feel that, above all, education for engineers in the operating field should lay the foundation for original thinking. The purpose of engineering education should not be to train men to do things which have been done before. The improvements of the future, the new things for better living, will not come about by having engineers doing the same things repeatedly. In fact, the burden of routine repetition will dull the creative mind. Repetitive technical jobs can be done by technicians who are employed by the tens of thousands in the communications operating industry and trained by the industry or by technical institutes.

There are four additional points I would like to make about the nature of the engineering job in the communications operating field.

—It is very big. The operating branches of the Bell System alone have about 6000 engineering graduates who, in creating communication services, make use of the products of about 1800 engineers in development and research and 2500 in manufacturing. In addition there are many more communication operating engineers in such fields as audio and television broadcasting, domestic telegraph, overseas radio communications services, air, land and sea transportation and the newspaper field.

—It involves high stakes. For example, in the telephone industry alone, engineers are responsible for investing well over a billion dollars each year in new plant. Seeing to it that the existing plant is kept in good condition and is used well so as to give the most possible and the best possible service involves expenditures of another billion dollars each year.

—The rewards in job satisfaction and monetary compensation for men of equal ability are as great in the communications operating field as in any branch of engineering.

—A second rater will be no more successful in the operating engineering field than he would be in research and development or manufacturing.

The impression I want to leave with you is that the education of engineers for the communications operating field should not be subordinated in your planning

* Presented at the Annual Meeting of ASEE, Electrical Division, University of Illinois, June 17, 1954.

of curricula for engineering education. You should not place all the emphasis on the training of the best undergraduates to be specialists in highly technical fields with the broad engineering education needed by engineers in the operating field reserved for the less capable. The operating field needs and provides rewarding careers for many of the very best engineering graduates.

Why Are Engineering Graduates Needed for Communications Operations?

An engineering education is a most valuable asset in a number of assignments in the communications operating industry.

In an industry so firmly rooted in complex technology, all levels of management including top management need a large proportion of men who have an engineering background. They need to have a good understanding of the technical devices, systems and phenomena involved in communications in order to make wise decisions in the conduct of the business. Fortune magazine recently surveyed the three highest positions in each of the 300 biggest U. S. industries and found that 45% of the men holding these positions had engineering training. In the communications industry the proportion is at least as great. You may say there cannot be much wrong with engineering education when it can produce graduates who carry such a large part of the leadership in industry. But I'm sure industry would get even better management if the planners of engineering college curricula would have these management aspects in mind.

Another group in the communications operating field who need engineering training are the men who make the long range fundamental plans for expanding and improving present communication services and for establishing new services. These are the people who are blazing the trails that will be followed on into the future. They guide the research and development engineers as to what is needed for the future and, of course, are guided by them as to what is possible. Engineering education can provide for them a thorough understanding of engineering fundamentals so they can deal intelligently with the highly technical devices and phenomena which are the building blocks for the systems of the future. But, in addition, engineering colleges should teach them objective and systematic methods of analysis, basic economic concepts and the fundamentals of effective written and oral presentations of engineering studies.

The detailed planning to carry out the long range fundamental plans for communications plant also requires a great deal of original thinking in a highly complex field. Most of this new plant is tailer-made to fit a particular situation—planning for it is not merely a matter of following a handbook. Engineers are needed to sketch out the broad outlines of the plans so that technicians can fill in the details and carry them out. The engineer in this area, therefore, must have the ability to supervise the work of others, as well as to originate the broad plans. How well he does the job can have an important bearing on costs and service since he deals with very large construction expenditures. For example, the project engineer for the job of converting a single manual telephone office to dial operation may deal with equipment costing several millions of dollars and the many decisions he makes as he goes along can have important effects on the cost and effectiveness of the job.

Still another activity of the engineer in the communications operating field is in the actual construction of new plant—the placing of coaxial cables across the country, or cables and amplifiers under the sea, or radio relay stations on mountain tops. This involves a thorough understanding of the complex plant for which he has the construction responsibilities. When he meets with unforeseen difficulties created by man or nature, he

needs to make changes on the spot if the job is to get done well, economically and on time. The proper decisions are facilitated if he has an engineering background which, in the case of the construction engineer in the communications field, goes beyond electrical phenomena into mechanical and structural fields. In addition to engineering know-how, he must know how to deal with people.

There is still another area in the communications operating field where an engineering education is of great value. This is in the day-to-day management of the communications plant. In the Bell System, for example, nearly a billion dollars a year is spent for the operation and maintenance of the plant. There is great opportunity for originality in this job. Again the engineer needs a good understanding of the technical fundamentals of communications plant. He must be cost and service conscious. He must know how to instill the desire to do the job well and economically in the dozens or hundreds of technicians carrying out under his direction a wide variety of highly technical tasks under a wide variety of conditions.

What Should Engineering Education Provide for the Communications Operating Field?

Throughout my talk I have emphasized the importance of originality and creative thinking because I believe that that is a prime requirement for an engineer in the operating field (as it also must be in research and development and manufacturing). Equally I have tried to point up the fact that most of the work in the operating field that needs men with engineering training is of a supervisory or management nature. There are only a few positions in the operating field that will provide real job satisfactions for capable men with engineering degrees that do not ultimately involve supervision of others and working in close cooperation with others.

Education for the engineer in the communications operating field, therefore, should furnish him with the basic knowledge which will be helpful to him in creative thinking pointed toward ever more and better communication service at increasingly favorable costs and in managing men and money toward this end. It seems to me this should include:

1. An understanding of the fundamentals of science and engineering with emphasis on physical rather than mathematical concepts.
   —it is important to develop an understanding of physical phenomena but knowledge of particular devices or techniques is of value only as examples of the application of phenomena.
   —mathematics is of importance as a tool for understanding and explaining the physical phenomena but can be subordinated to that purpose.
2. Emphasis on electrical (including electronic) principles but for the operating field basic chemical, mechanical and structural principles also should be well covered.
3. Objective and systematic analysis of engineering problems.
   —the place for approximate versus exact analysis should be brought out.
   —a good concept of probability and sampling theory is a great help in analysis of operating problems.
4. A better-than-average understanding of costs and economic principles as applied to engineering planning.
   —a dollar spent in the future carries less weight than a dollar spent today.
   —initial cost is only part of the story; annual charges over a period may be even more important.
   —depreciation must be understood and allowed for adequately.

—judgment must be applied to the results of economic studies in reaching final decisions: the cheapest plan is not always the best engineering answer.
—the importance of doing the overall job so as to produce the earnings which a business needs to be healthy and to be able to make the investments required to provide "the better things for better living" which the public wants.

5. The principles of effective oral and written presentation of the results of engineering studies and plans.
—needed to "sell" new ideas to the managers of the business and to direct technicians in carrying them out.

6. Human relations—working with and supervising others—knowledge of how to share and how to motivate.
—in the operating field, the most successful engineers are not lone workers or specialists but members of a team and often team managers.
—the times require that the manager in business know about people as well as about things—today he spends more and more of his hours on human problems.
—there are many indications that the typical engineer is not at his best in providing the participation and motivation for subordinates which leads to high morale.
—engineering colleges have an important responsibility in providing the background which will help their graduates in handling the human problems associated with management.

I believe all these things can be adequately covered in a 4 or 5 year college course by putting more emphasis on principles and less on techniques and specific applications. The latter can best be gotten on the job—in fact, it is the job of the engineer to create them.

College Notes

Construction has begun on the new half-million dollar engineering building at **Bradley University** in Peoria, Illinois. The new building is expected to be ready for the new school year opening 1955. It will adequately provide for an enrollment of 600 engineering students.

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January 31–February 11, 1955
Engineering and Management Course
University of California, Los Angeles

This is a two-week course for executives, supervisors, engineers, industrial analysts, cost accountants, and other line and staff personnel. Each student selects his program of study from thirty-five classes in subjects ranging from production management, motion and time study, quality control, and leadership, to mathematical programming, electronic data processing, and automation. The classes will be taught by members of the **University of California,** Los Angeles staff augmented by fifteen key men from industry. Early morning instruction in public speaking is optional. The $300 fee includes the cost of texts and course materials, ten luncheons, and three dinners. For information write to:

Edward P. Coleman, Coordinator
Engineering and Management Course
College of Engineering
University of California
Los Angeles 24, California

The Allison Program of Summer Employment for College Professors

By M. D. ADAMS

Associate Professor of Physical Sciences and Assistant Head, Technical Institute, Purdue University

To the Editor of *The Journal of Engineering Education:*

Several articles have appeared in the JOURNAL recently regarding summer employment for engineering educators in industry. Most of these opportunities have usually been considered in relation to the engineer members of the instructional staffs. The following letter represents an evaluation of my own experiences in such a program from the viewpoint of the non-engineer teacher. This summary was prepared originally for the Allison Division of General Motors in Indianapolis, Indiana, where I have been employed during the summers of 1953 and 1954.

August 24, 1954

Allison Division
General Motors Corporation
Indianapolis, Indiana

No one in engineering education today questions the desirability of industrial experience for the engineer members of engineering instructional staffs. In fact, it is generally accepted as a necessity. But for the non-engineer instructor (such as I) the need for such experience has not been so clearly recognized. Even when recognized as desirable, the opportunity for worthwhile experience close to the field of engineering has been greatly restricted. As a consequence the mathematics, physical science, social science, and communications instructors, or others in engineering colleges have often had an inadequate or erroneous concept of how their instruction can best be adapted to meet the educational needs of engineering students. Such lack of understanding—often associated with strictly academic backgrounds and viewpoints—has sometimes led not only to misunderstandings but lack of sympathy for the objectives of engineering education itself.

As a non-engineer, working in Engineering Education, I wish to thank and commend Allison for extending the summer employment program for College Professors to include other than the engineer members of the instructional staff. It is my belief and experience that the close associations with practicing engineers in a typical industrial situation will prove as valuable to the nonengineer instructor as to the engineer. My experience in technical writing leads to the belief that many other non-engineers could gain valuable engineering experience and association in that field while at the same time rendering useful and needed services to industry.

Effects of Allison Work Experience on Me

Due to my two summer employment periods here, I have:

1. Seen that industry (at least at G.M.) recognizes its position and obligations in the task of engineering education and is ready and willing to work in cooperation with the engineering schools in every way.

2. Seen that the great range of specializations, and rapid changes in indus-

trial procedures have made it mandatory that the curricula of engineering colleges deal largely in the fundamental concepts, basic skills, and universal attitudes upon which engineering is based. These fundamentals ensure delivery of a suitable candidate to industry for efficiently and effectively taking full advantage of their highly specialized on-the-job training programs.

3. Seen that engineering usually represents team work of the highest order and that a basic requirement in all engineering education is the development of the necessary skills, and personal attitudes and traits so important for satisfactory team work.

4. Seen that in industrial practice various forms of communications have been developed to a place of great importance, and that facility in written, oral, graphic, and mathematical communications of ideas is a basic requirement of engineering education.

5. Seen that industry has recognized the great importance of the personal elements, of developing men of integrity and high moral character with a sense of human dignity and worth. (The friendly and helpful cooperation extended to me by Allison employees, and the high morale on the part of all are evidence of the degree of success in this direction at Allison.)

6. Learned a vast number of applications of engineering and scientific principles that will serve to enrich my own teaching.

7. Learned, with new emphasis: that technological education and training consist of more than producing engineers; that there is a need for all levels and degrees of skills and knowledge usually acquired through vocational schools, technical institutes, four-year colleges, and graduate schools of science and engineering; and that the highest degree of success will result only when all these educational systems work together with one another and with industry in effectively meeting the needs of a civilization that has become highly dependent upon technology.

What Have Been the Direct Benefits of My Services to Allison?

1. By choosing to specialize in one very narrow field of engineering (Disk Vibrations in Turbojet Aircraft) it was soon possible to make a limited contribution to certain engineering practices.

2. There does exist, and has for years a shifting of engineering education emphasis toward a more scientific base and away from the over-stressing of engineering as an "Art." By approaching and solving a few problems from the scientific viewpoint, with emphasis on basic principles, I may have served to demonstrate in a modest way that such approaches were powerful engineering tools. Conversely by observing the extent to which engineering as an art can and has produced results, my own thinking and appreciation have been shifted in this direction from an over-emphasis of the rigorous scientific and mathematical approach. This tendency to shift toward common ground in this respect is undoubtedly good for all concerned.

3. A fair degree of success in unearthing valuable new information through the library in connection with disk vibration, may have served to give this fundamental step in research a more important position in the minds of test engineers with whom I have been associated here.

What Have Been the Long Range Benefits of My Services to Allison?

The long range benefits to Allison depend upon what I do with the knowledge, skills, and attitudes which I have acquired here. Any such benefits are based on the sound premise that whenever technological education improves or is benefitted that Allison, together with all industry, will ultimately benefit in one way or another.

As a counselor, teacher, supervisor, and administrator, working directly and indi-

rectly through and with many instructors and many hundreds of college students and high school students, the opportunity certainly exists for attitudes, ideals, and knowledge acquired by me at Allison to be multiplied many-fold in its ultimate influence on many.

Recommendations

1. Broaden the base of the summer faculty to include at least 50% of engineers but a sampling of all the other general fields associated with technological education, to broaden the viewpoint of all.

2. Extend the seminar idea to include weekly meetings with unified, cooperatively-planned programs. (This summer's activities were far superior to those of last because of that.)

3. Publicize the program and the opportunities through the Journal of Engineering Education, as well as through the Deans of Engineering Colleges.

4. Follow through with letters to Deans, Department Heads, etc., acknowledging the participation of members of their staff, pointing out that military restrictions made publicizing on their part impossible for many worthwhile engineering and scientific contributions.

5. Consider a broader policy that might be called "Cooperative Education-Extended to Faculty." In such a program exchange agreements between college and industry might be worked out to bring the Industrial employed Engineer to the college for a semester and the Professor into industry. (This does not necessitate nor imply a specific exchange of jobs.) Such a program might be established on a small scale with top flight Professors and Engineers and extended if its success should warrant this action.

New Members

ALI, MIR M., Chief Instructor in Power, Pakistan Technical Institute, Pakistan. H. R. Beatty, W. E. Marsh.

ALLEN, THEODORE, JR., Associate Professor of Mechanical Engineering, University of Wichita, Wichita, Kansas. M. H. Snyder, J. W. Dunn.

BONDURANT, BYRON L., Head, Department of Agricultural Engineering, University of Maine, Bangor, Maine. R. B. Rhoads, F. W. Peikert.

BONELL, JOHN A., Associate Professor of Civil Engineering, University of Nevada, Reno, Nevada. H. B. Blodgett, J. R. Van Dyke.

BRICKNER, JOSEPH L., Instructor in Engineering, Central Technical Institute, Kansas City, Mo. V. E. Vilander, C. V. Curtis.

BROWN, HAROLD H., Instructor Central Technical Institute, Kansas City, Mo. N. E. Vilander, C. V. Curtis.

CARTER, ROBERT J., Associate Professor, State University of New York, Albany, N. Y. F. E. Almstead, W. H. Branch.

CHASE, EDWARD L., Staff Assistant, Engineering Training Department, Bell Aircraft Corporation, Arlington, Texas. R. W. Reynolds, C. E. Knott.

COLEMAN, THOMAS C., Assistant Professor of Civil Engineering, Northeastern University, Boston, Mass. W. C. White, W. T. Alexander.

COOK, EVERETT L., Instructor in Aeronautical Engineering, University of Wichita, Wichita, Kansas. M. H. Snyder, J. W. Dunn.

DALE, ALVIN C., Associate Professor of Agricultural Engineering, Purdue University, Lafayette, Indiana. G. E. Spencer, J. L. Waling.

DE MARCHE, JOHN M., Assistant Professor of Civil Engineering, Louisiana State University, Baton Rouge, La. W. P. Wallace, L. J. Lassalle.

DUPRE, EDMUND J., Associate Professor of Chemistry, New Bedford Institute of Textiles and Technology, New Bedford, Mass. J. E. Foster, L. R. Coombs.

DURBETAKI, PANDELI, Instructor in Mechanical Engineering, University of Rochester, Rochester, N. Y. L. D. Conta, R. F. Eisenberg.

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Section Meetings

Section	*Location of Meeting*	*Dates*	*Chairman of Section*
Allegheny	Bucknell University	April, 1955	W. D. Garman, Bucknell University
Illinois-Indiana	University of Notre Dame	May 21, 1955	G. E. Ellithorn, University of Notre Dame
Kansas-Nebraska	University of Nebraska	Oct. 22–23, 1955	G. W. Bradshaw, University of Kansas
Michigan	Michigan State College	May 17, 1955	C. C. Sigerfoos, Michigan State College
Middle Atlantic	Brooklyn Polytechnic Institute	Dec. 4, 1954	H. N. Jenkins, Swarthmore College
Missouri-Arkansas	University of Missouri	April 2, 1955	M. M. Jones, University of Missouri
National Capital Area	Catholic University	Oct. 5, 1954	J. C. Michalowicz, Catholic University
New England	Massachusetts Institute of Technology	Oct. 9, 1954	E. R. McKee, University of Vermont
North Midwest	Michigan College of M. and T.	Oct. 8–9, 1954	C. J. Pratt, Michigan College of M. and T.
Ohio	A.F. Inst. Wright	Sept. 17–18, 1954	K. F. Sibila, University of Akron
	University of Akron	May 7, 1955	
*Pacific Northwest	Oregon State College	Spring, 1955	M. L. Jackson, University of Idaho
Pacific Southwest	University of California, Berkeley	Dec. 28–29, 1954	B. M. Green, Stanford University
Rocky Mountain	Colorado A. & M. College	April 16, 1955	D. F. Peterson, Colorado A. and M. College
Southeast	University of Tennessee	April 14–16, 1955	H. V. Flinsch, Mississippi State College
Southwest	University of Oklahoma	April 8–9 1955	V. L. Doughtie, University of Texas
Upper New York	Cornell University	Oct. 22–23, 1954	N. A. Christensen, Cornell University

Members of the Society are welcome at all Section Meetings

*** No Date Set.**

Young Engineering Teachers' Paper Contest

RULES

Eligibility: Members of ASEE who are not over 35 years of age (their 36th birthday must not be before June 1, 1955).

Awards: First prize $200—Second prize $100.
Honorable mentions as determined by the Judging Committee.

Presentation of Awards: The awards are known as the "President's Awards." They will be presented to the recipients by the President of the Society at the Annual Banquet at Pennsylvania State University, June, 1955.

Subject: Papers should deal with some constructive phase of improvement of engineering education. Participants are encouraged to use their own judgment in selecting appropriate subject matter.
The following are suggestions of possible subjects:

1. Professional development of the Young Engineering Teacher.
2. How should the student be helped to learn to deal with situations that are new to him, on his own initiative and with well-ordered professional thinking?
3. To what extent should modern physics be included in the engineering curriculum and how should this be done?
4. What areas of physics, chemistry, mathematics and biology not now taught in engineering curricula are likely to be translated into significant engineering practice in the next 25 years and how should this influence present curricula?
5. To what extent and in what manner should undergraduate instruction acquaint the engineering student with the methods of research and with recent research developments in engineering and closely allied sciences.
6. What should be taught of the art of engineering as contrasted with its science?
7. What basic science, mathematics and communication principles and skills can best be taught by separate department staffs and what part by integration into engineering courses?
8. What can be done in college to prepare the young engineer to continue to learn after his formal education is ended?
9. How should non-major courses in engineering such as electrical engineering for non-electricals be planned as to content and method?

Length of Paper: Not to exceed 2500 words.

Submission of Entries: All entries should be submitted to the Chairman of the ASEE Section in which the member resides before March 1, 1955. Names and school affiliations of Section Chairmen are published each month on the page in the Journal of Engineering Education designated "Section Meetings." Papers submitted in the contest last year or in other contests are not eligible for this year's contest.

Judging: Each Section of ASEE will appoint a Judging Committee to select the best paper from the Section. This paper will be submitted to the ASEE Secretary before April 1, 1955.

The winning papers from the various ASEE Sections will be submitted to a Final Judging Committee for the final selection.

Here is an opportunity to gain national distinction. Good luck!

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"ARTICLE XI, Section 3. (Election of Officers) By means of a form to be printed in The Journal of Engineering Education or in the preliminary program of the annual meeting, an opportunity shall be given to individual members of the Society to submit names of persons to be considered for said officers. These names, on the form provided, shall be sent to the Secretary of the Society not less than sixty (60) days prior to the annual meeting; and the Secretary shall submit the suggested names to all members of the Nominating Committee."

In order to make the election of officers of the Society as democratic as possible, members are urged to fill out the nomination form and return before April 1, 1955 to the Secretary, A. B. Bronwell, Northwestern University, Evanston, Illinois.

I nominate the following members of the Society for officers:

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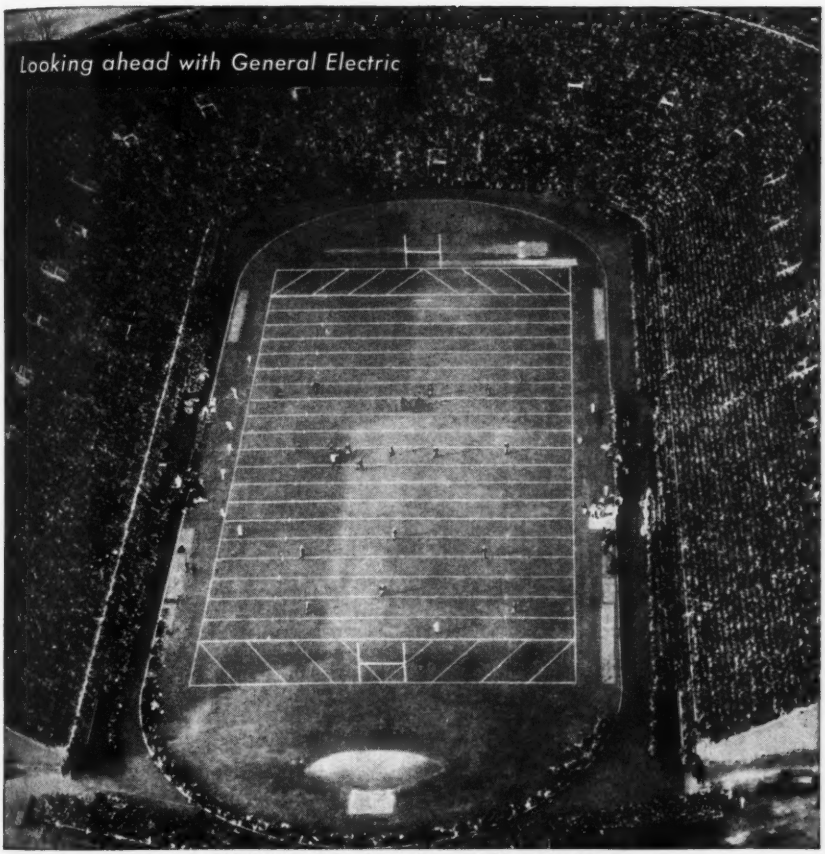

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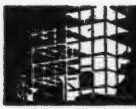

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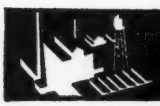
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